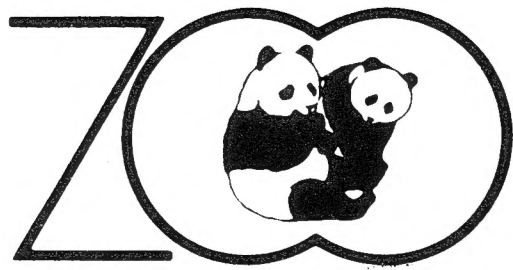


ZOOGOER

July-August 1988



**Friends
of the
National**



is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, to increase and advance the welfare of its animals.

ZooGoer [ISSN 0163-416X] is published six times a year by Friends of the National Zoo to promote its aims and programs, and to provide information about FONZ activities to its members, volunteers, and others interested in the purposes of FONZ. The nonmember subscription rate is \$10 a year. Third class mailing permit no. 6282. Copyright 1988, Friends of the National Zoo, National Zoological Park, Washington, D.C. 20008. All rights reserved.

The National Zoological Park is located in the 3000 block of Connecticut Avenue, N.W., Washington, D.C. 20008, (202) 673-4717. Weather permitting, the Zoo is open every day except Christmas. Hours: From May 1 to September 15, grounds are open 8 a.m. to 8 p.m.; buildings, 9 a.m. to 6:00 p.m. Director: Michael H. Robinson.

Membership in FONZ entitles you and your family to many benefits—publications, discount privileges, and invitations to special programs and activities to make your zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, D.C. 20008, or call (202) 673-4960.

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Cover: *While many large mammals face extinction in the wild, hippopotamuses remain surprisingly abundant in the lakes and rivers of sub-Saharan Africa. (Photo by Bob Citron)*

A Tribute to Volunteers for Conservation

On this most special occasion, the National Zoological Park and the Friends of the National Zoo are pleased to announce a joint plan for a very exciting tribute to volunteers for conservation.

For 30 years, Friends of the National Zoo volunteers have worked selflessly in support of the National Zoological Park. In recognition of these dedicated women and men, FONZ and the NZP have commissioned a sculpture for the Park as a permanent symbol of their extraordinary contributions to the Zoo.

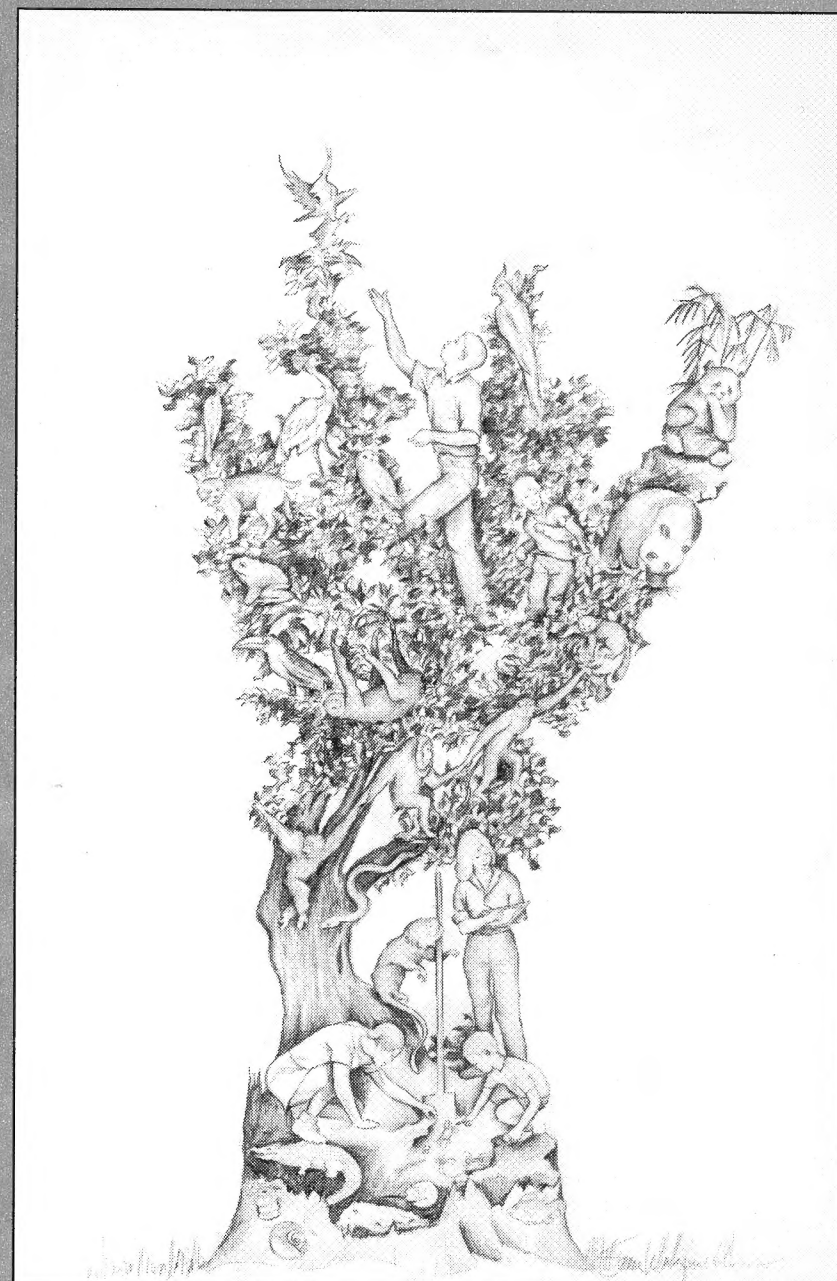
The monumental work of art is being sculpted out of a huge fallen oak tree by nationally acclaimed artist Steven Weitzman. As Weitzman's preliminary sketch suggests, the sculpture will depict the integral role of volunteers in the success of Zoo conservation programs. The white oak, which for more than a century graced the grounds of the Zoo, will thus be transformed into a symbol of hope for the future of wildlife, and dedicated to the FONZ volunteers who embody the spirit of the Zoo's conservation mission.

One of the most exciting aspects of this project is that the artist will create the work at the Zoo, on the great meadow in front of the Reptile House. Here, visitors will be able to watch the sculptor give new life to the fallen oak. The sculpture will also enhance the beauty and diversity of the Park. Indeed we hope this will be the first of many Art in the Park projects to be developed by the FONZ/NZP partnership to make the National Zoo truly a Biopark, exhibiting the splendors of the entire biological world.

Sincerely,

Michael Robinson, Director
National Zoological Park

George A. Didden, III, President
Friends of the National Zoo



ZOOGOER

VOLUME 17 • NUMBER 4 • JULY-AUGUST 1988



32.14 Chinese Bronze: Late Chou Dynasty, Dragon Head. (Courtesy of the Freer Gallery of Art, Smithsonian Institution, Washington, D.C.)

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*Jeffrey A. McNeely and
Paul Spencer Wachtel*

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All's fair in love and war, but while some male animals fight tooth and nail to win females, others take a more subtle approach.

Here Be Dragons

People traditionally learned to live with dangerous crocodiles through common sense, myth, and ceremony. Crocodiles have their good points and may be more valuable in the swamps than as leather.

Jeffrey A. McNeely and Paul Spencer Wachtel

 Southeast Asia was *terra incognita* to Europeans until 700 years ago. Alexander the Great had bullied his way to the Indian subcontinent; but in general the world the early European cartographers knew stretched north to Norseland, south to the Mediterranean, and east to Egypt. Within these confines, empires of the moment were colorfully defined. But what of the lands beyond the known borders? In that era before Marco Polo the early mapmakers could agree only that the netherworld must be a fearsome place indeed, filled with such horror and mystery that no one would ever return from a visit. So to fill in the blank spaces to the east the early European geographers conscientiously inscribed a warning: "Here be dragons."

They had no idea how right they were.

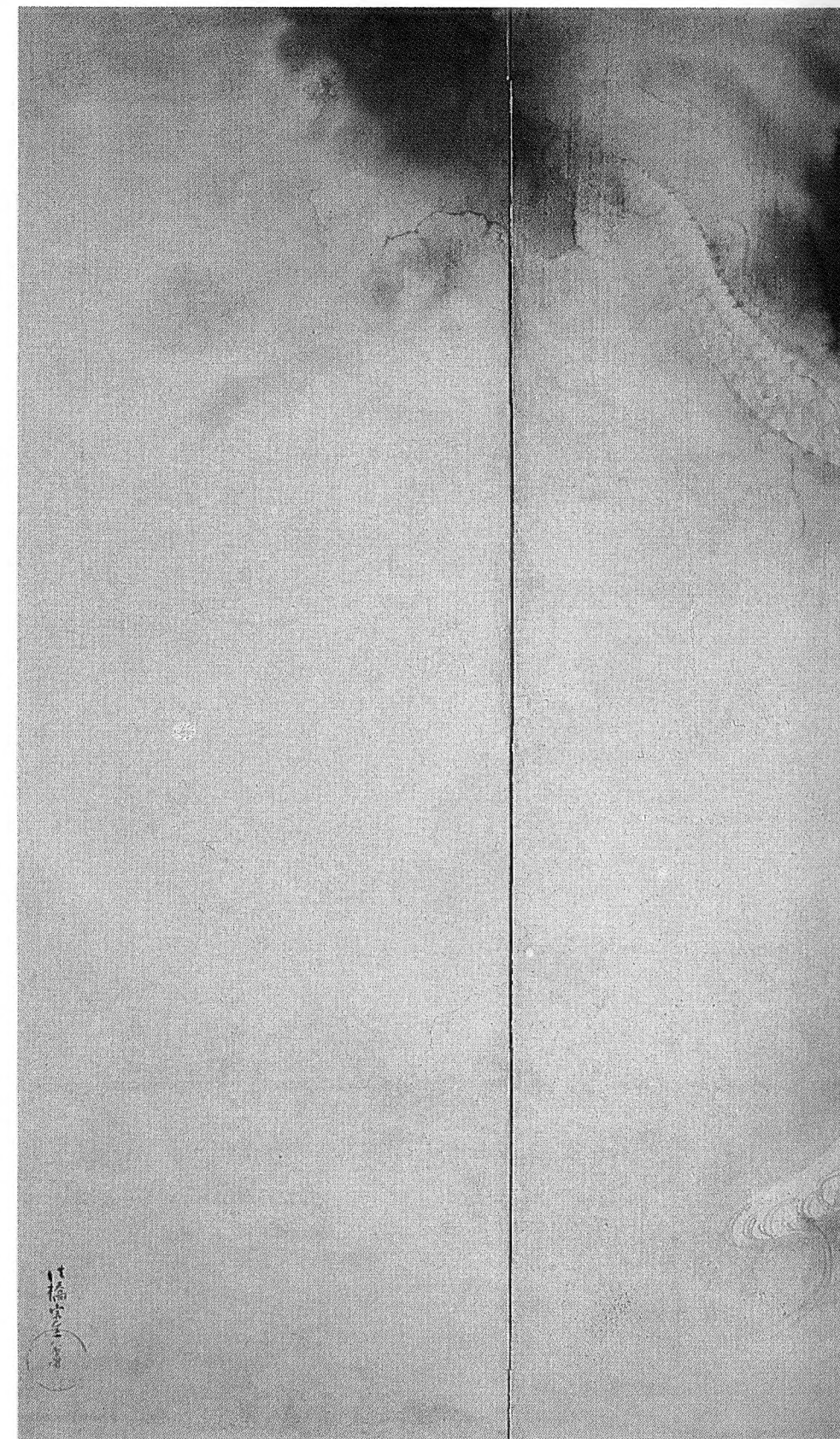
For in the tropics of the East, dragons are alive and well, embodied as the crocodiles which are still the dominant predators in rivers, lakes, and swamps. Like many things Asian, the dragons of the East are complex and surprising. The Eastern dragons are not the fearsome, humorless monsters of biblical allegory and medieval European imagination. Just the opposite.

"The Eastern dragon," writes the Japanese philosopher Okakura Kakuzo, "is the spirit of change, therefore of life itself. Hidden in the caverns of

inaccessible mountains, or coiled in the unfathomed depth of the sea, he awaits the time when he slowly rouses himself into activity. He unfolds himself in the storm clouds; he washes his mane in the blackness of the seething whirlpools. His claws are in the fork of the lightning, his scales begin to glisten in the bark of wind-swept pine trees. His voice is heard in the hurricane, which, scattering the withered leaves of the forest, quickens a new spring."

The idea of the dragon, found through much of tropical Asia, was always strongest in China. The stylized creature may have been based on the Chinese alligator, an animal found only in China whose closest relative lives in Florida (crocodiles can show a toothy smile even when their mouths are closed while alligators just smirk—their teeth fit neatly together when their jaws are shut.) This dragon ancestor spends the winter in its cold, muddy den and emerges in the spring, bringing with it the return of nature's energies; it is thus the symbol of the reproductive force of spring, and a protector of Chinese culture. Adding golden wings and a hot breath produced a symbol which understandably came to personify the emperor.

Tropical Asia is a paradise for crocodilians, with the beasts infesting rivers, estuaries, and coastlines from Pakistan to Australia. The saltwater crocodile covers the whole region, and four freshwater species live in India, Thailand and Indochina, the Philippines, and New Guinea. The two most fearsome forms are harmless to people; the gavials which live in India and Nepal and false gavials inhabiting freshwater



swamps from Burma to Indonesia are both fish-eaters armed with a long, narrow snout packed with dagger-like teeth.

Just as tigers dominate the land from India to Sumatra, so crocodiles rule the waters of tropical Asia. From Borneo and Java eastward, they are the dominant carnivore, and the animal most feared by

Above: 05.230 Japanese Painting: Momoyama-Edo period Rimpa Sotatsu Dragons. (Courtesy of the Freer Gallery of Art, Smithsonian Institution, Washington, D.C.)

people. A creature which is known to attack and eat people is given considerable respect, at least partly in the belief that the animal's power comes from close links with the spirits. Crocodiles provoke deep fear, but like tigers they are venerated and respected, and at times given anthropomorphic qualities and treated like people. It has been live and let live, as most people were cautious about tempting the crocodiles and the crocodiles were protected by taboos and generally inefficient hunting methods.

The Tempasak Dusuns of Sabah, for example, don't kill crocodiles because one of the beasts once married a Dusun girl. This crocodile, the myth goes, had five toes on each foot, instead of four like most crocodiles. According to British anthropologist Owen Rutter, "The people of Tempasak say that if they could be certain a crocodile had the reg-

islands where crocodile attacks have always been made more frequent by human overpopulation.

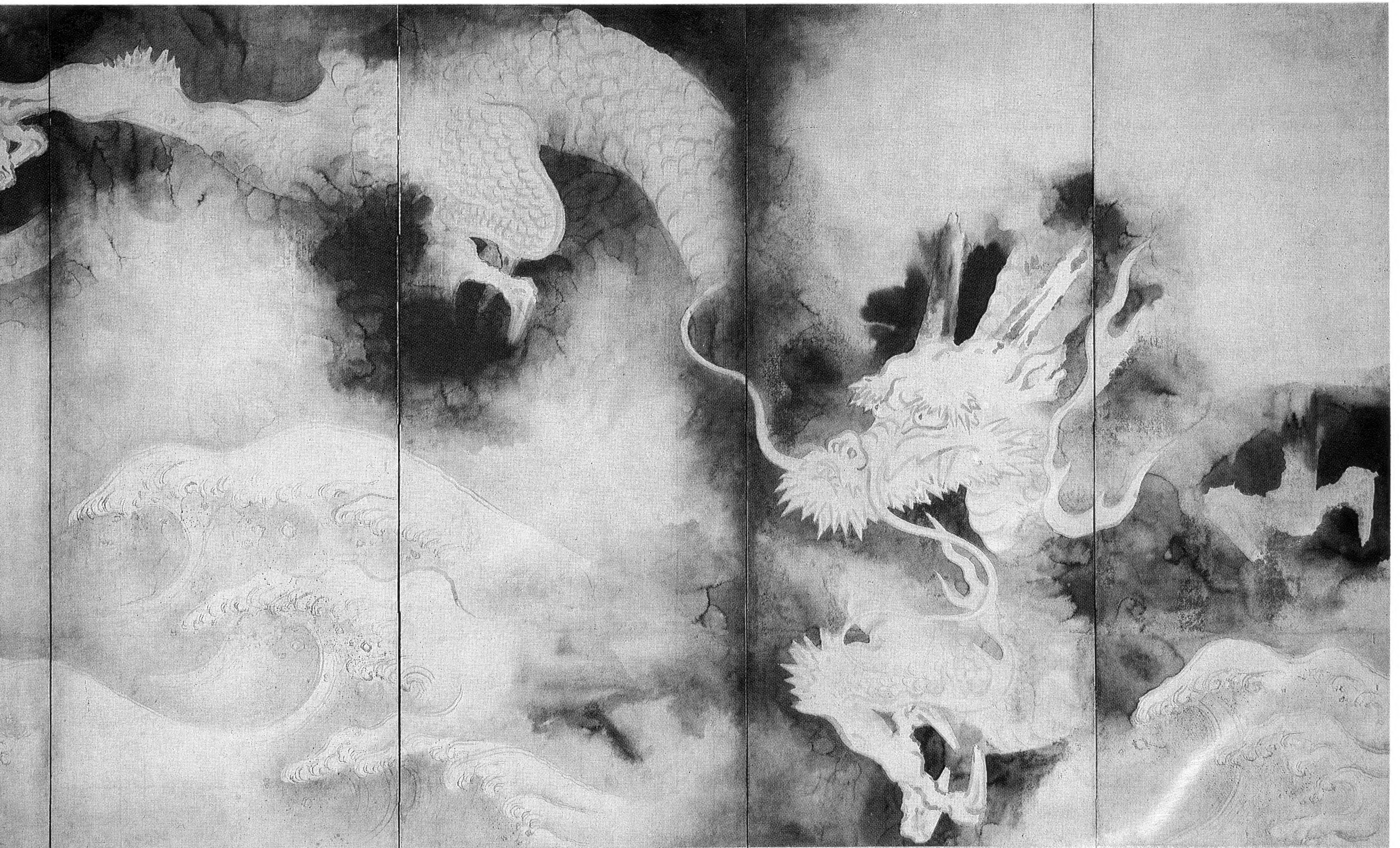
- On the island of Ceram in the Indonesian Moluccas, women were thought sometimes to mate with crocodiles. The offspring were always twins, one human, one reptilian. The baby croc born of this union was released into the river and fed by its mother until the crocodile's human brother was old enough to take over the responsibility. In return, the crocodile's magic protected the family. On ceremonial occasions large boating parties took food out to the river, singing to their crocodile brothers and inviting them to join the feast. Drawn by the music, the crocodiles soon appeared and devoured rice, tobacco, and betel nut.

- According to German anthropologist W.F.A. Zimmerman, some groups even practiced what might

with flowers, was placed on a sacred stone at the water's edge where she patiently waited for her suitor to carry her off to his riverine lair. She accepted this rather cavalier treatment because she had been taught that the crocodile would marry her and treat her like a princess.

- On the east Indonesian island of Buru, priests determined that a sudden increase in crocodile attacks was due to the passion a crocodile prince felt for a certain girl. The priests forced the unfortunate girl's father to dress her as a bride and deliver her to the crocodiles.

In all these cases, people made a deal with the crocodile. "We'll look after you," the humans seemed to say, "if you leave us alone." Muslims in some parts of Indonesia believe crocodiles, like tigers, are forbidden by the natural law laid down by Nabi Sleman (King Solomon) to kill humans. If any crocodile breaks



ulation four toes, they would not hesitate to kill it, but since crocodiles seldom proffer their feet for inspection, they prefer to run no risks in slaughtering a possible relative by marriage."

The feelings of veneration and awe toward crocodiles have been expressed in some unusual ways in the past, particularly in the eastern Indonesian

be considered preventive maintenance. In the 1700s the Rajah of Kupang, on the east Indonesian island of Timor, annually sacrificed a royal virgin to the estuarine crocodile, logical enough since the royal family considered themselves descendants of crocodiles. The girl, beautifully dressed in her finest sarong, doused with perfume and garlanded

Sleman's law, it will be driven out of its group and forced to live alone.

Sometimes the crocodile finds it hard to stick to a fish and game diet, and must be captured. As with tigers, this requires a *pawang*, who will use both magic to deal with the spiritual side of hunting and long practical experience to deal with the animal side of the beast.

Throughout the coastal region of Southeast Asia, wherever the fierce saltwater crocodile still survives, certain gifted men have become crocodile bounty hunters. According to Edwin Gomes, a missionary who spent 17 years living among the Dayaks of Borneo, “whenever a human being has fallen a victim to one of these brutes, a professional crocodile catcher is asked to help to destroy the murderer. The majority of natives will not interfere with the reptiles, or take any part in their capture, probably fearing that if they did anything of the kind, they themselves may some time or other suffer for it by being attacked by a crocodile.”

Some crocodile hunters make the wayward animals an offer they can't refuse:

Ye crocodiles who are upstream, come down.

the water and the crocodile, perhaps imagining that it belongs to a man in distress and therefore an easy meal, approaches and takes the bait of rotten meat.



Malaysian officials called in local and Indonesian crocodile *pawang*s to capture an animal that attacked at least 17 people living near Sarawak's Batang Lupar river in the early 1980s. One victim was a prawn fisherman who was said to have been held aloft in the reptile's jaws and paraded back and forth in a grisly show of defiance. Stories circulated that the crocodile, named *Bujang Senang* (a play on words that literally means “happy bachelor” but

the carcass of a 15-foot-long crocodile. For the moment, it was once again safe to bathe in the Batang Lupar.



People who are faced daily with the possibility of being attacked and eaten by a predator far more powerful than themselves have developed psychological and religious defenses against fear: Crocodiles are our spiritual brothers and won't hurt us; they only take sinners, and I'm good; I haven't done them any harm, so they won't hurt me; I won't take unnecessary risks by calling their attention to me; and if I really have a problem I can call in a *pawang* who will use his magic to deflect any danger from me.



Crocodiles, like Asia's freshwater mugger (Crocodylus palustris), often lie in wait at waterholes, where prey inevitably turn up to drink. (Photo by John Seidensticker)

And ye crocodiles who are downstream, come up.

For I will give you all good food.

As sweet as sugar and as fat as coconut.

I will give you a beautiful necklace.

As the chant continues the caller's voice reaches the moaning intensity of a man deep in prayer—or wracked with pain. His piercing voice carries far over

also “a young man from the nearby Senang river”), was the invincible ghost of a murdered Iban warrior which could be captured only through supernatural means. When the police hunters failed to kill the offending croc, the *pawang*s were called in to capture the beast through magic.

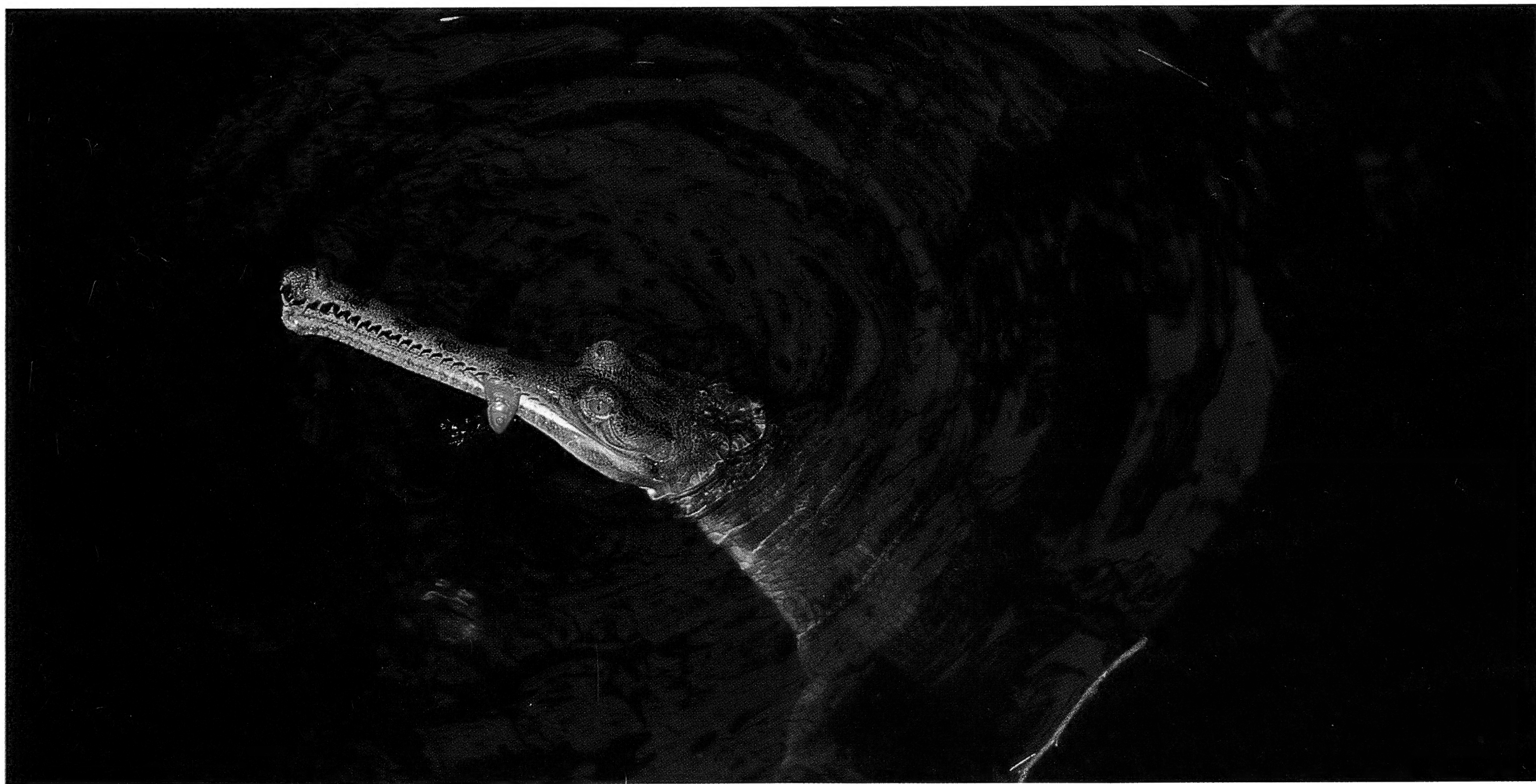
After several years of effort, Malaysian authorities proudly exhibited

Still, it never hurts to have insurance. An old man who ran the ferry across the Barito River at Banjarmasin in southern Kalimantan in the 1920s set himself up in business. “He has capitalized his skill and cunning by organizing himself into a sort of crocodile liability company,” noted the American traveler E. Alexander Powell. “Anyone may secure a policy in this company by paying him a

weekly premium of 2.5 Dutch cents. When one of his policy holders is overtaken by death in the form of a pair of four-foot jaws the old man turns the

the tribal people have always known and expressed in their mythology—crocodiles provide a definite benefit for humans. Consider:

releasing nutrients on which fish can feed. Crocodiles are supreme scavengers. The Burmese knew the reptiles quickly recycled any corpses thrown



The endangered gharial (Gavialis gangeticus) of the Indian sub-continent is primarily a fish-eater; in the Zoo, goldfish are the mainstay of its diet. (Photo by Jessie Cohen, NZP Graphs)

ferry over to one of his children and sets out to fulfill the terms of his contract by capturing the offending saurian, recovering from its stomach the weighty bracelets, anklets and earrings worn by the deceased, and restoring them to the next of kin."



While the man-crocodile relationship may be a bit fragile at times, societies that include crocodiles in their belief systems actually live in better harmony with their environment and enjoy increased productivity from the rivers, lakes, and estuaries which provide sustenance to both man and crocodile.

Modern cultures generally share with simpler societies an emotional feeling that conservation is necessary and good, a feeling that is possibly part of the collective subconscious which was earlier represented by mythology. But modern societies often have a need to rationalize things, so scientists, as high priests of technology, have studied the reasons for conserving crocodiles. Their investigations have shown what

- In areas with a long dry season, crocodile wallows and other diggings become important drinking ponds for wildlife (though not without risk to the drinker).

- Young crocodiles eat large quantities of snails and have been credited with helping to control snail-spread diseases such as schistosomiasis.

- Studies have shown that the presence of crocodiles in a river actually *increases the yield of fish*, which by itself justifies the veneration village societies have for the beasts. Crocodiles eat ailing fish in a significantly higher proportion than healthy fish, thus improving the common health of the fish stock. By preying on the most common fish, they balance the fish population; any species which suddenly becomes dominant is put back in its proper proportion. Crocodile droppings are nutritious for the fish and contain critically important chemicals.

- Crocodiles have a tremendous effect on the flow of nutrients in the river. The river bed is a rich mud saturated with algae and small animals. When the crocodile swims, the broad sweeps of its tail and serpentine twisting of his body stir up the river bottom,

into a river, thus saving the price of a cremation while putting the nutrients back into circulation.

By serving both a conservation function and a deeply felt mythological need, beliefs promoting coexistence with crocodiles became integrated in human cultures.



The dictates of style have changed people's perception of crocodiles. Crocodiles had lived comfortably for 200 million years before anybody noticed that their skins make good wallets, but now that hunters have been stimulated by a strong seller's market, crocodiles everywhere are being slaughtered for their hides. And people get greedy. A Papuan hunter told us that a few years ago a drought forced the crocodiles into a small area of the swamp where hunters could easily shoot as many as they wanted. Such an opportunity attracted villagers from miles around; the men from the village, who had traditionally hunted at a sustainable level, were forced to shoot as many

crocs as possible so the outside hunters would not take all the skins.

The result? The glut on the market drove prices of crocodile skins so low that hunters could barely meet their expenses. And even worse, the crocodile population was so reduced that the traditional hunters had great difficulty finding any wild crocodiles. Overexploitation had destroyed a sustainable source of income, largely because nobody had the responsibility to protect the reptiles.

Concerned governments, of both importing and exporting nations, have taken legal steps to ensure that the world can have both its crocodiles and its handbags. Traditional controls on exploitation are being replaced by sanctions that modern governments understand—fines and jail sentences. Most Asian countries now give crocodiles some legal protection, though enforcement under isolated conditions is always difficult.

A more effective way of controlling trade is at the receiving end, so all trade in crocodiles is now regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This agreement controls dealings in wildlife and wildlife products by requiring that every animal and animal product carry a certificate of origin to prove that it did not come from a country where it is protected as an endangered or threatened species. International commercial trade in crocodiles is prohibited among the more than 90 countries which are party to the treaty unless the animals derive from captive-bred or certain wild populations which are known to be able to sustain some harvesting. Even then, strict quotas attempt to limit the impact of commercial trading on wild crocodiles.

Trade regulations, however, only work when there is something to buy and sell. Where will the supply of "legal" crocodiles come from?

Some people hope that the answer can be found in crocodile "ranching," which involves leaving the large adults in the swamps while their eggs and young are collected for rearing under some sort of controlled environment for the three or four years it takes for them to grow long enough to become billfold material. This approach is based on sound biological sense. Female crocodiles can lay up to 70 eggs per year, and most of them hatch. But it's a tough new world for the baby croc because in the wild it is the breakfast of choice for all sorts of predators, including storks, herons, fish, turtles, giant frogs, and even adult crocodiles, which together ensure that over 80

percent of the young that are hatched never celebrate their first birthday.

But baby crocodiles saved from predators and brought into captivity grow quickly, gaining one pound of weight for each two pounds of food consumed (cattle, pigs, and sheep require three to five times as much food to gain the same weight). According to a study by the U.S. National Academy of Sciences, this "makes crocodiles probably the most nutritionally efficient land animal for commercial husbandry. Only the growth of some fish is comparable."

Ranching seems a sensible approach to managing crocodiles in Papua New Guinea, where the human population is sparse and extensive areas of swampy crocodile habitat cannot really be used for anything else. With 30,000 crocodiles on ranches in Papua New Guinea, villagers have sufficient stock to earn a reasonable living by supplying skins that keep European boutique owners happy. The availability of ranched crocodiles also takes pressure off wild populations so that crocodiles can continue their life in the rivers and estuaries.

In theory, the same system could be widely applied in remote areas of the lowland tropics, where crocodile skins may provide the only readily marketable resource. But abuse of the system where it is being tested elsewhere in Asia is common. Many of the ranches seem to be little more than fronts for the sale of skins taken from the wild. They are supposed to rear juveniles up to 30 inches long caught in the wild, but in fact animals of all sizes are being taken. It seems highly unlikely that the crocodile trade is always and everywhere going to be carried out in the sustainable manner which seems to be working in Papua New Guinea.



In crowded Thailand, the New Guinea "ranching" model can't work because few crocodiles survive in the wild and most of the crocodile habitat has been taken over by man. The innovative Thais have found another way to provide crocodile skins for the market: farming crocodiles bred in captivity.

The most successful crocodile farm in Southeast Asia is in Pak Nam, 30 miles south of Bangkok in the mangrove swamps near the delta of Thailand's Chao Phya River. Owned by a Chinese immigrant, Utai Yangprapakorn, the farm is so successful that Utai is able to send each of his 12 children overseas for an education he never had.

Renowned Thai conservationist Dr. Lekagul Boonsong took us down to help Utai prepare some papers for IUCN's Crocodile Specialist Group, which gave him the chance to tell the outside world how his system worked. Utai explained how he got started. "I began the crocodile farm in 1950 with \$500 and just 20 little crocodiles I caught in the swamp. I tried to learn all I could about crocodiles and their breeding habits, and I attempted to duplicate their wild conditions here on my farm. By 1960 we hatched 150 crocodiles and now we're hatching between 3,000 and 5,000 a year." At Utai's Samutprakan Crocodile Farm and Zoo Co., Ltd., two vast crocodile breeding tanks took up two and a half acres each and dozens of small peninsulas extended into the brackish water. Crocodiles basked everywhere, like singles around a Beverly Hills pool. In the trees toward the back of the pen the wall was lined with little sliding doors leading to the nesting pens.

Utai described to us the long and intricate courtship of crocodiles, the unlikely of lovers. Submission by the female is an important part of the process, and the male must always be bigger than the female in order to overcome her initial reluctance, which she often expresses by loud hissing and puffing up her cheeks. The male never bites her, but butts her with his head or thrashes her with his tail. Once she has submitted, his behavior becomes much more suave. He sidles up alongside his consort, rubbing his nose against hers, stroking her belly with his nose, and sinking quietly underneath and blowing bubbles to gently stimulate her underparts. After a long sojourn of gentle courtship, mating finally takes place in the water after sunset. The male roars, warning all other males to stay away and once again impressing the female with his grandeur. The female answers by raising her head high out of the water, her jaws wide open and pointed to the sky. The male rubs his body alongside the female, grasps her around the neck in a tender caress, hooks his tail under hers to lever himself into position and bends his body under hers, in a reptilian Kama Sutra. The female sometimes lies on her side so that her vent is turned to receive the male. Sometimes they copulate for only a few minutes, sometimes for nearly an hour.

A few weeks later the female enters her nesting box where she lays her eggs. She is then chased out of the nesting box and the staff of the crocodile farm take over her maternal chores. They ensure that the temperature of the

nest is optimal, keep a watchful eye on the eggs, and, after 10 weeks, open the nest to release the young.

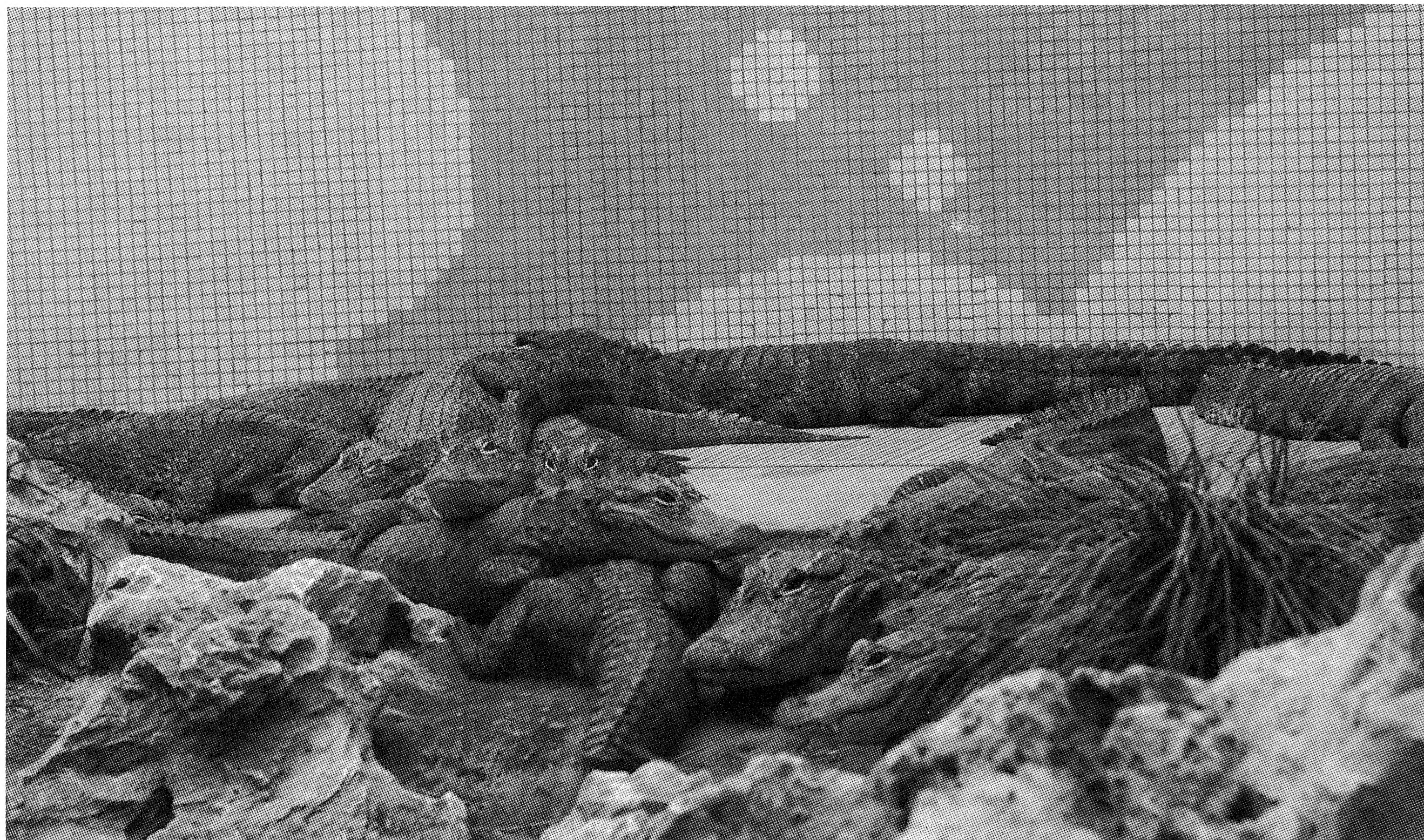
The crocodile farm, which by 1974 was supplying 80 percent of the Thai crocodile skin trade and has now virtually cornered the market, is one of the major diurnal tourist attractions around Bangkok. Each year one million visitors come to gape, and Utai not only

look. "Each pond has over 200 breeding crocodiles," he explained, "with one male to every three females. We want to make sure each male finds the lover he likes," he added with a tolerant smile.

Utai's papers were well received, even though the chairman of the Crocodile Specialist Group was still suspicious—with some justification—that Utai was buying wild crocodiles brought

regularly take young crocodiles from the wild to replenish stocks. Even crocodile farming operations top up their animal populations with wild animals—it seems wild crocodiles will be free of abuse only when there are no more left to be captured.

On the other hands, ranching operations which are run well, such as the ones on Papua New Guinea, can stop



The Chinese alligator (Alligator sinensis) is critically endangered in the wild, but zoo breeding programs provide hope for their survival. (Photo by John Seidensticker)

earns money from admission (three dollars for foreign tourists) but from refreshment stands, elephant rides, photographers who take a picture of you with a tame python wrapped around your shoulders, stands selling fish to feed the crocodiles, and gift shops that sell stuffed baby crocs. Lacquered crocodile heads go for about \$15 while tiny feet are a bargain at three dollars each.

Skins earn Utai between \$90 and \$250 each, depending on size, species, and the strength of the international market. Not only the skins are valuable, however. The meat is sold to local restaurants (two dollars per pound) and as a treatment for asthma, and teeth are used in Thai medicine. Utai's total take from an average crocodile (skin plus meat) in 1986 was about \$350.

Utai strolled along the elevated walkway built to give visitors a closer

to him by rural villagers. Utai was made a member of the group, but was later expelled when he started using similar captive-breeding methods for tigers, which he fed with surplus crocodile meat.



Conservation laws were not needed in the days when people and crocodiles lived in a sort of balance, killing each other with reasonable discretion. But in past times, the benefits of a healthy crocodile population far outweighed the possible advantage of indiscriminately killing crocodiles. Today, the seductive market of the industrialized countries lures rural people to overhunt, thereby upsetting the balance. Most ranches are not conservation-friendly because they

the harvesting of adults and are therefore a step forward. Ranching needs the wild crocs, and, in the words of biologist Ron Petocz, "If the resource can't be used, especially such an ugly and 'dangerous' animal, there will never be enough lobby power to maintain crocs in the wild."

The crocodile skin trade may indeed be necessary to ensure the survival of the wild animals at a time in history which requires an economic value be applied to every resource, but the frequent abuses of the trade are making the ideal of "sustainable use" a mockery. And animals which were so well adapted that they flourished for eons may be unable to meet the challenge of 20th century fashion. □

This article is adapted from a chapter in the book Soul of the Tiger, recently published by Doubleday.

And Here Be Dragons...of A Different Sort

Mary-Russell Roberson

An eight-foot-long lizard lumbers through the forest, constantly flicking the ground with his light-yellow tongue. He comes into an open field and heads straight toward a carcass already being voraciously devoured by two slightly smaller lizards. He opens his mouth, inflates his throat and bows his large tail up behind him threateningly. The two other reptiles lower their heads and move aside, and the giant lizard steps up to the carrion and rips off an entire hind-quarter, swallowing it in one gulp.

Sound like a scene from "Land of the Lost"? Actually, this could be happening right now on any of several islands in Indonesia. The lizards are *Varanus komodoensis*—more commonly called Komodo dragons, Komodo monitors, or oras—and they are the largest lizards in the world.

Two Komodo dragons, believed to be a male and female, came to the National Zoo on May 12 from Ragunan Zoo in Jakarta, Indonesia, and went on exhibit here July 14. The two lizards, the only Komodo monitors currently in the United States, are a gift from the president of Indonesia to the people of the United States. In the last few months, zookeepers have been doing their best to keep the two animals healthy and to acclimate them to their new home. They must make sure the lizards' enclosure is kept at a constant temperature and contains hot spots of 105° to 110° for basking. They also carefully watch the lizards' diet to make sure they are getting all necessary nutrients. The monitors are fed rats—and an occasional chicken—two to three times a week.

While the relatively young lizards

now measure six feet, two inches and four feet, six inches, they will continue growing throughout their lives. Komodo monitors may grow anywhere from a fraction of an inch to several inches a year. Given their long lifespans, the inches add up. Scientists estimate that Komodo monitors can live up to 50 years in the wild. The longest Komodo monitor on record was a zoo specimen purported to be 10 feet, two inches. But most don't get so big: Five feet, seven inches was the average length of 50 monitors measured in the wild on Komodo Island.

An estimated 2000 to 5000 Komodo monitors live on four small islands in the middle of the Lesser Sunda Islands in the Republic of Indonesia—Komodo, Rinca, Padar, and Flores. Because there are so few lizards living on so few islands, Komodo monitors are listed as rare by the International Union for the Conservation of Nature and Natural Resources (IUCN). About 70 rangers are currently stationed on Komodo and Flores, making the lizards probably the most heavily protected reptiles in the world.

Scientists think that the Komodo monitors originated at or near their present distribution perhaps more than 10 million years ago. They speculate that the islands were originally part of the same landmass. When that landmass subsided, millions of years ago, the lizards were left on separate islands. Though they can swim at least two-thirds of a mile at a time, they don't often move from island to island. Later, during the Ice Ages, the islands may have become connected again as the sea level fell.

Today, the Komodo monitors have the

smallest range of any large carnivore. Scientists estimate that their entire range on the three tiny islands and on Flores only amounts to a total of about 345 square miles (about one-fourth the area of Rhode Island).

Komodo monitors are scavenger-predators, meaning that they eat carrion when it is available and kill live prey when it is not. Small, immature monitors commonly eat insects, rodents, and birds. Larger, older lizards eat deer, wild boar, smaller monitors, and occasionally domestic water buffalo. Very rarely, say the locals, the lizards may attack and even eat humans. However, scientists have not documented this behavior.

The lizards' shark-like teeth enable them to saw off huge portions of flesh. They can swallow large, oddly shaped pieces because their skulls are equipped with movable joints and plates, as are snakes' skulls. Komodo monitors can swallow entire boar heads, and even whole fawns and piglets. They sometimes push particularly large or unwieldy chunks against the ground to force them down their throats. They need to eat about one large animal a month, although they can survive for longer periods without food.

Scientists think that the monitors locate carrion by using their highly developed sense of smell. As they walk, their smell-sensing tongues constantly flick at the ground, apparently searching for whiffs of their next meal. When they get near carrion, their meandering path

Opposite page: Zoo staff hope to repeat the Surabaya Zoo's success in breeding Komodo dragons. (Photo by Bela Demeter)



VOYAGE TO KOMODO

Bela Demeter

At eight o'clock in the morning, the sun was already beating down, glaring off the treacherous waters of Nusa Tenggara. Torn by currents and whirlpools, this narrow passage between the Indonesian islands of Flores and Komodo was all that separated us from wild dragons.

At last we were nearing our destination, Komodo Island, after months of anticipation and a voyage halfway round the world. But the slow, choppy pace of our rented fishing boat left us no alternative but to sit back and contemplate the clear blue sky and reflect upon the last week and the chain of events that had led up to this moment.

Just seven days earlier, we had been sitting in the lounge of the Jakarta Airport, talking with local conservationist Chuck Darsono. This marked the start of our official visit to Indonesia and Jakarta's Ragunan Zoo, where NZP Curator of Reptiles Dale Marcellini and I were to pick up a pair of young Komodo dragons. Now found only on a few remote Indonesian islands, these remarkable creatures are the largest lizards in the world. The animals had been presented to the people of the United States by Indonesia's President Soeharto as a result of President Reagan's 1986 visit to Bali, but it had taken almost two years to gain the permits that would allow us to bring them to a new home at the National Zoo. Now, in a foreign country, with a bureaucracy of its own, we dared not rest easy until we—and the crated dragons—were airborne on the return journey.

But we were to be more than mere escorts for the lizards. A major purpose of our visit was to research the needs of our new charges by observing the lives of

dragons in the zoo and in the wild. In order to do this, we obtained permits to visit Komodo Island from the Ministry of Forestry. The Ministry also generously paid the daily expenses of our island expedition and provided us with a guide. Samedi, a forestry student, would also be making his first visit to Komodo.

Over dinner that night, we laid out our itinerary. From Jakarta we would go to Bali, then catch a commuter flight to Lombok, then another to Sumbawa. A smaller plane would take us on to Labuhanbajo on Flores. From there we would need to rent a boat for the rest of the trip to Komodo.

Sounded simple, but as luck would have it, we learned on Wednesday in Bali that the plane to Flores now flew only on Fridays and Sundays. Determined to make the best of the delay, we went on to the Surabaya Zoo to see the dragons they had bred a few years before. The Zoo's professional staff were enthusiastic and generous with their knowledge of the animals; one staff member was native to the island of Flores and gave us a letter of introduction to his uncle, the chief of police in Labuhanbajo.

Only the most adventurous tourists visit Komodo—the logistics of travel to the island dissuade all but the most determined. And those that do come have a single purpose—to see the almost legendary dragons.

Following a long, sweltering flight to Flores in a tiny airplane, we landed at the Labuhanbajo airfield. Park officials met us with a jeep—the only vehicle capable of negotiating the rough roads—and took us into town. There we arranged to hire a boat which would carry us on to Komodo the following morning.

The boat ride—at five hours, all too leisurely for our taste—took us to the Park Service's compound on the hot, dry island. About a mile down the beach is a small fishing village, where about 600 people live in four rows of houses built on stilts right off the beach. Chickens and goats are kept in the open areas beneath the houses, where they make an occasional meal for the dragons. Dragons rarely raid the village, however, as they are well fed by tourist groups which bring goats to lure the animals into view. First on our agenda was a hike to the arena where the dragons are baited; along the way, we spotted our first dragon resting in the shade of a tree near the coast. The arena is actually a dry stream bed, walled by high, steep banks. From a fenced observation platform, we saw a few of the enormous dragons lingering around this feeding site, and soon a small group of tourists arrived with a ranger and the requisite goat and we witnessed the feeding ritual in its entirety.

Those lizards at the edges of the arena livened up with the arrival of the goat, whose bleating drew more giant lizards from the stream bed we had searched in vain only moments before. The goat was killed, cut open, and lowered into the depression. Still more dragons emerged from the forest until a total of 20 or so dragons, some more than nine feet long, were pulling and tearing at the sacrificial goat.

The scene was grisly but impressive, although we sensed that the dragons of this area had become accustomed to these easily earned meals: About 3000 groups of tourists visit Komodo each year, and each group brings a goat.

We spent the next few days exploring



other parts of the island—the savannah slopes of Mount Ara, the beaches, and the riverine forest of Poreng—in quest of what turned out to be rather elusive dragons. Burrows and tracks are abundant along the stream beds but actually spotting one of the animals is difficult.

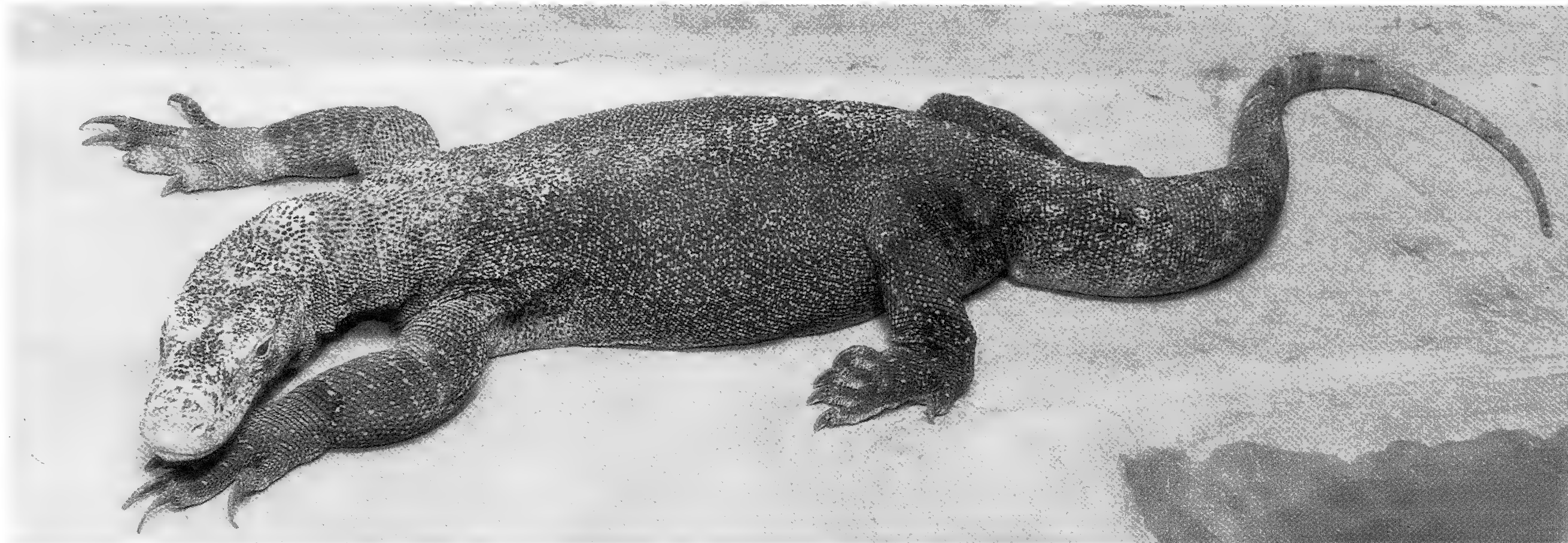
Komodo itself is harsh and remote, and it may be these very qualities that have kept the lizards from the brink of extinction. Yet we couldn't help wondering whether we had witnessed the beginning of the end for these creatures on Komodo. During our few days we encountered two separate film crews recording the feeding ritual as a promotion for tourism.

Three thousand groups each year is a significant number; will increasing numbers lead to increased commercialism and development? How many more feeding arenas can be created before Komodo's remaining groups of lizards in fact become domesticated? And yet, it is the attention of tourists and their economic clout that makes these animals a resource worth conserving in the eyes of some of the country's decision-makers. To balance the beneficial and negative aspects of the tourist trade, the Indonesians have designated an area of Komodo Island as a sanctuary zone where tourism is prohibited. In addition, the smaller

islands of Rinca and Padar, which are also home to the dragons, are closed to visitors. Having witnessed the remarkable spectacle of the dragons first-hand, we can only be encouraged by Indonesia's efforts to promote wildlife tourism while offsetting its impact on the dragons' lifestyle. □

Bela Demeter is a keeper in the Reptile House.

Above: Two fishermen paddle toward the small village that hugs the coast of Komodo Island. (Photo by Bela Demeter)



One of the Zoo's pair of Komodo dragons gets acclimated to the temporary quarantine enclosure. This young lizard's dappled orange-and-black coloration will probably change to gray as it grows older. (Photo by Jessie Cohen, NZP Graphics)

straightens as they home in on the source of the smell.

While many scientists used to believe that the Komodo monitors were exclusively scavengers, the lumbering lizards actually hunt surprisingly well. Because they can only run about 10 miles per hour, they never chase their prey. Rather, they wait in ambush along well-traveled game trails or stalk sleeping animals, again using their keen sense of

smell to locate their meal. When they are within about a yard of their prey, they catch it by surprise. They may seize the prey's neck and thrash the animal around until it dies, or they may slice out huge chunks of its flesh, causing the animal to bleed to death.

There is some evidence that Komodo monitors sniff out pregnant prey in particular. If they arrive at the right time, they may be rewarded by a newborn. If not, their harassment of the mother may produce a miscarried fetus. A miscarriage has the added benefit, from the monitor's point of view, of temporarily incapacitating the mother, making her more vulnerable to attack.

Hunting, scavenging, and basking fill the daytime hours of Komodo monitors. At night, they hole up to sleep. They may find a natural nook—like a small cave or overhanging ledge—or dig a burrow. They sleep alone.

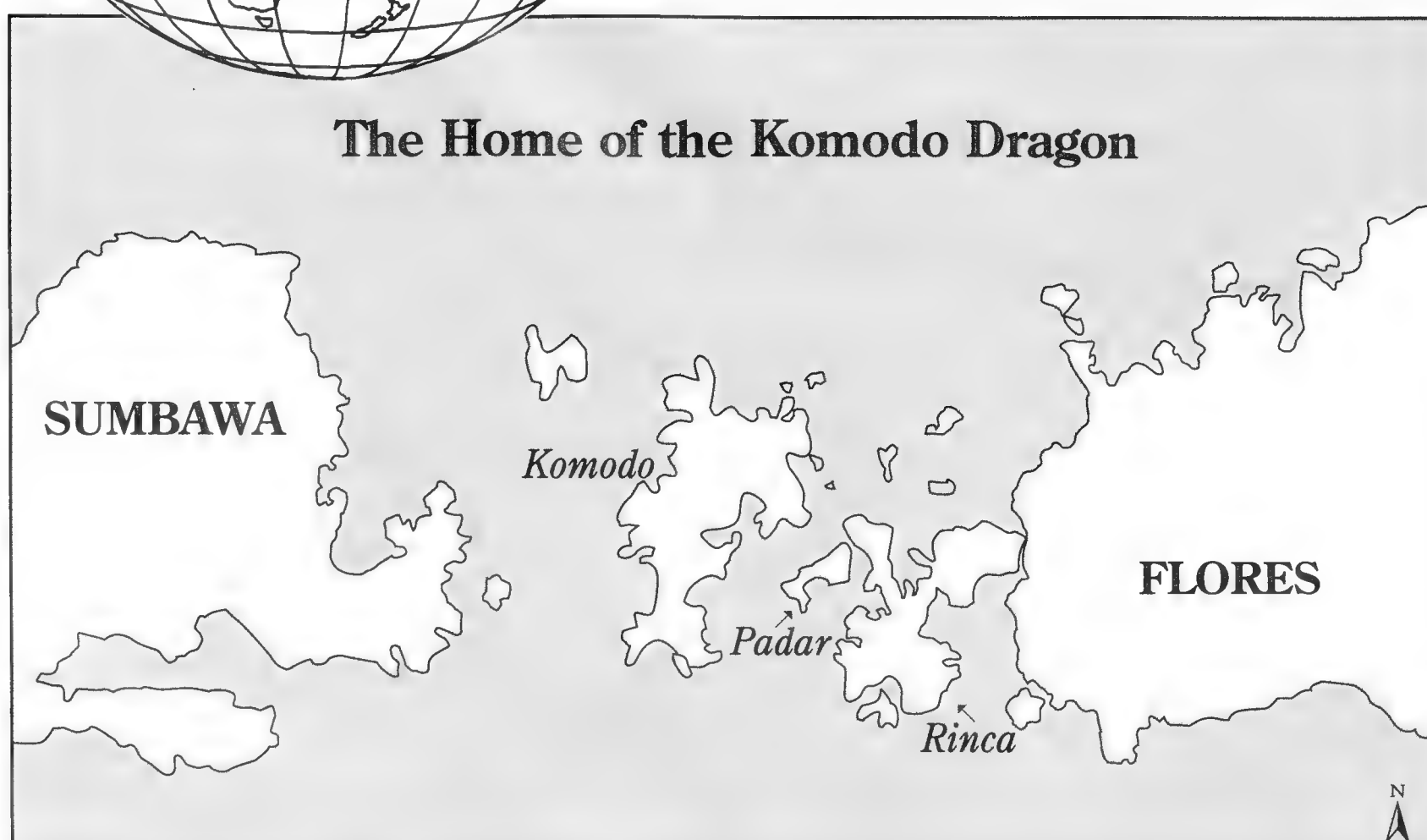
The solitary lizards apparently establish and reinforce status hierarchies

through two main behaviors: interacting at carrion and marking trails with their dung. For example, in the first paragraph, the largest and most dominant lizard asserted his rights by a display of aggression—opening his mouth, inflating his neck, perhaps hissing, and cocking his powerful tail back. The two smaller lizards accept his assertion of power by lowering their heads and backing off to let him take the choicest parts of the carrion for himself. Scientists think fecal deposits contain chemicals which may communicate to other monitors information about the individual's identity, territory, status, or sexual maturity.

Courtship in these beasts is short and violent. The male chases and scratches the female until she allows him to mount her. Unlike many other lizards, Komodo monitors apparently use more chemical cues than visual displays during courtship: Both lizards lick each other often during courtship and mating.

Most mating takes place in the early summer. Females dig a nest and lay about 20 eggs—slightly larger than chicken eggs—late in summer. The eggs hatch about eight months later, producing foot-and-a-half long hatchlings, which must fend for themselves. Baby monitors usually take to the trees to hunt for insects and smaller species of lizards.

Here at the Zoo, keepers will anxiously watch for any signs of mating or nesting in our two Komodo dragons. It is hoped that the pair will breed; however, Komodo monitors have not often bred successfully in zoos outside of Indonesia. While the two might not produce young, their presence here symbolizes the Zoo's awareness of the need to protect Komodo dragons and their limited natural habitat. □

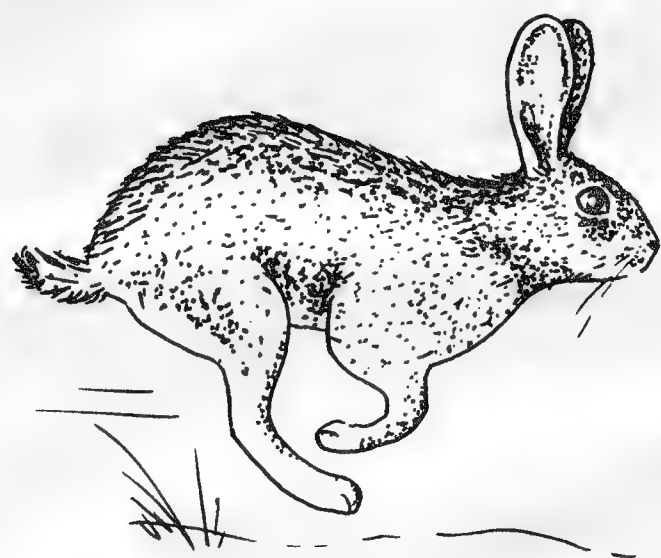


Tales of the Trickster

by Kathryn Lehnhardt
 Drawings by Sriyanie Miththapala

You hear folks say Brer Rabbit is full of tricks. But what some folks call tricks is just animal sense. He was born little, and the littler creatures are, the more sense they've got to have, because they need it. Brer Bear may be strong, and Brer Fox may be sly, but Brer Rabbit can outdo both of them.

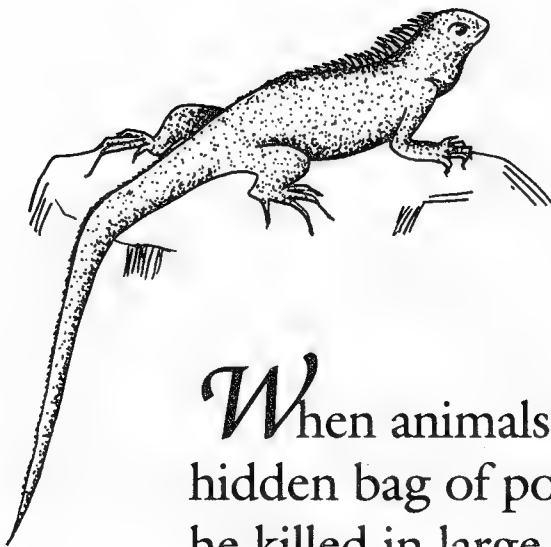
—From *JUMP AGAIN!*
 by Van Dyke Parks



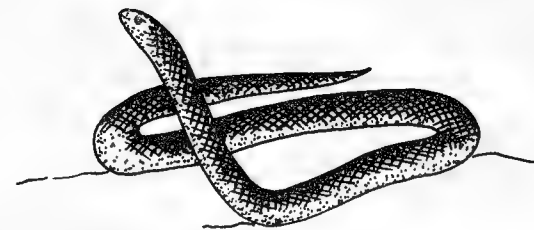
*T*ricksters like Brer Rabbit are common characters in stories and fables. An animal trickster is usually a weak and defenseless creature who still easily outsmarts much tougher or bigger animals. Trickster stories show that wit and courage are usually more important in life than brute strength. The clever hero goes through life with a pocketful of tricks and most of the time lands on his feet.

Rabbits and hares often appear as tricksters. Brer Rabbit is the best known trickster in American folktales. Tales from North and South America, Japan, China, India, Russia, and Africa all have some species of lagomorph (the scientific name for rabbits and hares) as a trickster. But other animals have also been cast in the trickster role. Turn the page to read about some surprising trickster stars from around the globe.

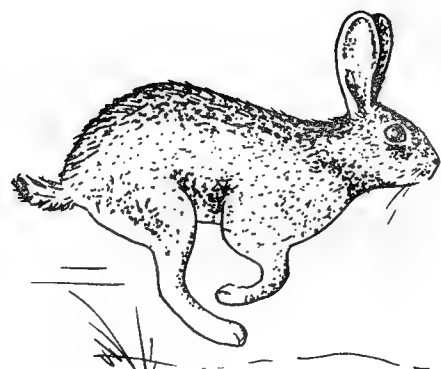
The Iguana and the Black Snake



This trickster legend of a cunning snake outwitting a man-eating iguana comes from the Aborigines of Australia.



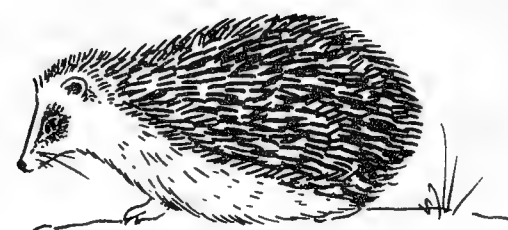
When animals were first on earth, Mungoon-gali, the largest of iguanas, carried a hidden bag of poison. His favorite food was the flesh of a human tribe called Daens, which he killed in large numbers. All of the other animal tribes met to find a way to save the few remaining Daens from the iguana, and selected Ooyu-bu-lui, the black snake, to help. He was determined to stop Mungoon-gali. But he knew that only with a clever plan could he hope to win, for the iguana was bigger, stronger, and quicker than the snake. Secretly, he also wanted to steal the poison bag for himself. One night he crept into Mungoon-gali's camp, where the iguana awakened to the snake's smell and rushed to kill him. But Ooyu-bu-lui quickly told him that the tribes were plotting against the mighty iguana. For many hours, the iguana tried to learn the details of the plan, but the black snake refused to say a word unless the iguana traded the information for his bag of poison. Finally, the iguana reached into his mouth and took out the bag. In a flash, Ooyu-bu-lui grabbed the bag, put it in his mouth, and raced away with his stolen prize. Ever since the snake has been poisonous—and as feared by the tribes as the now harmless iguana had been.



The Hare and the Hedgehog

The hedgehog is often a trickster in European folktales. In this story, the small, prickly hedgehog outwits a hare, who for once is not playing the trickster himself.

Hedgehog bets Hare he can outrun him in a race. Hare feels sure of victory but Hedgehog has a plan. First, he tells Hare that the race must be run in the straight, deep furrows made by a plough. This way, Hedgehog knows that Hare will not be able to see him during the race. Then he secretly tells his wife to stand at the finish line and pant heavily when Hare gets there. Hedgehog himself will never even leave the starting line. So Hare runs his fastest only to find the panting Mrs. Hedgehog already at the finish line. Hare cannot believe Hedgehog's easy victory, so they race through the furrows over and over. Still, Hedgehog always seems to be at the finish line first. Finally Hedgehog wins the bet, feeling lucky that he had chosen a wife who looked exactly like himself.

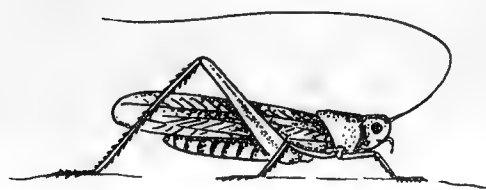


The Great Battle Between the Grasshoppers and the Monkeys

Small green grasshoppers are the unlikely tricksters in this tale from the Puyi people of southern China.



Long ago, the monkeys decided to move down from the cool mountains to live in the warm valley below. But the grasshoppers had always lived in the valley and they refused to let the monkeys in. As a battle begins between the grasshoppers and the bigger and stronger monkeys, the grasshoppers try a daring plan. They jump onto the noses of the monkeys! The monkeys respond by delivering fierce blows to destroy their nose-sitting enemies. The grasshoppers quickly jump before the blow strikes, and the monkeys repeatedly hit each other in the nose. Soon the valley is filled with unconscious monkeys. And to this day, the monkeys live in the mountains and the grasshoppers in the valley. (If you have trouble imagining a grasshopper as a hero, think of the wise and tricky Jiminy Cricket—crickets and grasshoppers are closely related.)



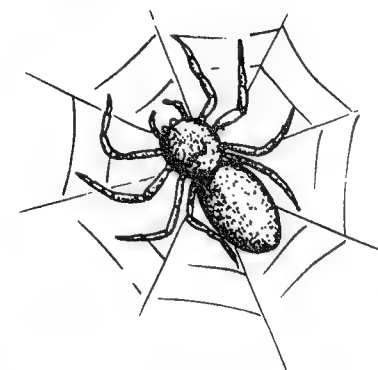
How Spider Got His Waistline

An ancient African legend tells how the spider Ananse collected all the stories in the world.

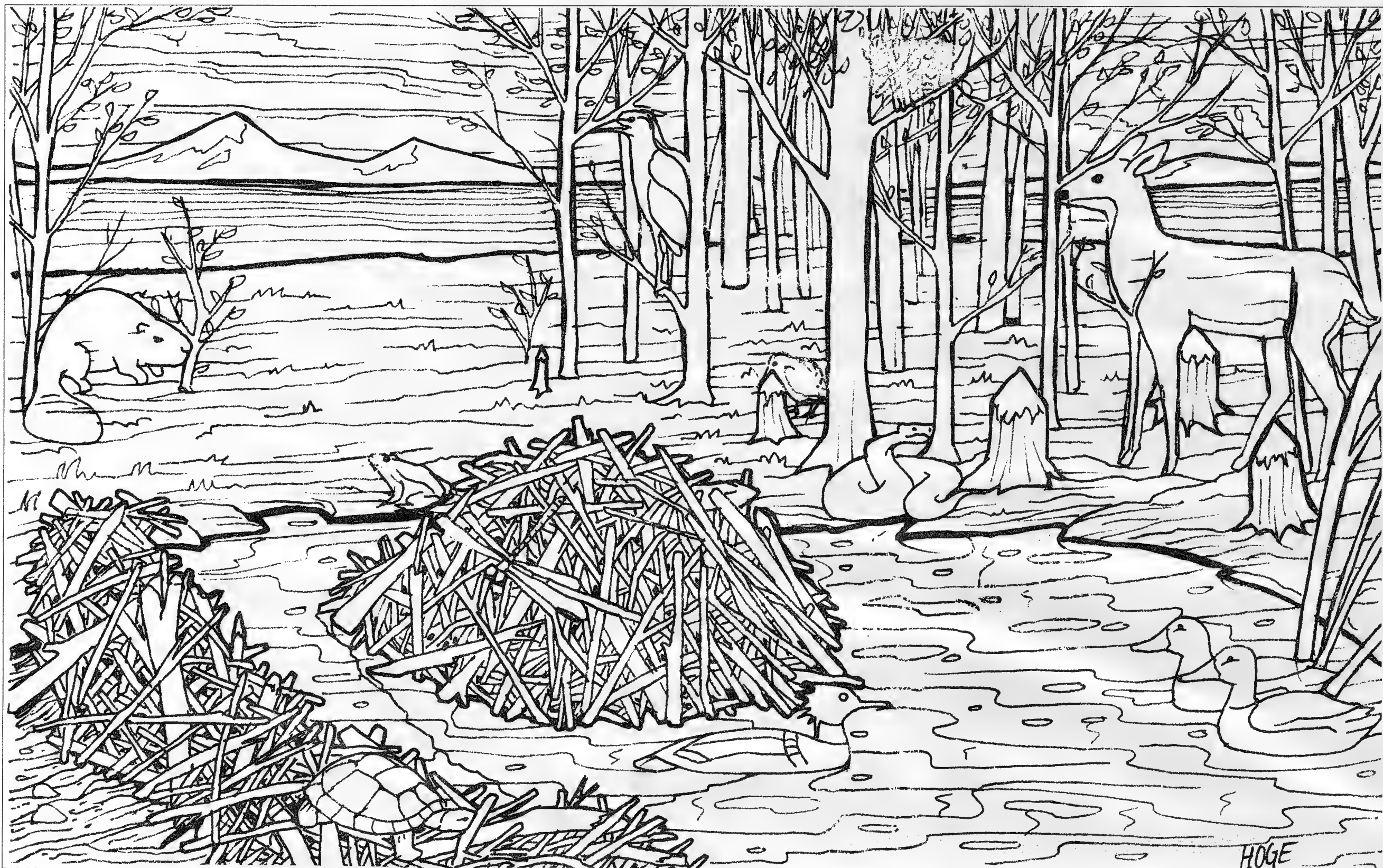
Of course, as the owner of all the stories, he then often chose quick, clever spiders as heroes.

Spider stories are typical trickster tales, telling how defenseless men or animals outwit others or narrowly escape from tight situations.

This spider folktale comes from Liberia in West Africa.



Spider needs the help of Firefly to steal fish from Leopard's den. Spider promises to share the fish with Firefly if he lights the way at night. Firefly agrees, but Spider cheats firefly of his share of fish for three nights in a row. Finally catching on to the tricky ways of Spider, on the fourth night Firefly leads Spider to the Leopard's den—and abandons him in the dark den. Leopard quickly catches Spider and wraps him up in strands of his own web. Spider struggles with the webbing and escapes. But one strand of web was wound so tightly that he could not remove it. This strand pinched Spider's waist, and ever since spiders have had an hour-glass shape.



Wetland Neighbors

by Christopher Hoge

Drive around the outskirts of a big city like Washington, and you will probably see bulldozers clearing land on which houses, malls, and offices will be built. More and more, this kind of development is taking over land that was once farms, woods, or swamps—land that was once home to wildlife. Some people would say that land without buildings or people on it is empty. But a closer look at wild land reveals a community of plants and animals that depend on each other for survival. Take this beaver pond, for example. At first glance, it may look empty, but in fact, a number of animals are hidden in and around the pond. Can you find them all? (Turn page upside down to read the solution)

Solution: deer, beaver, duck pair, frog, merganser, turtle, heron, snake, woodcock, dragonfly.

FONZ TURNS 30

To celebrate FONZ's 30th birthday, this year's Annual Meeting will feature a very special birthday party. On October 20, a birthday reception—complete with a huge birthday cake, of course—will take place at the Zoo. In addition, Russell Train, World Wildlife Fund President and former FONZ Board Member, will speak on FONZ's role in fostering conservation awareness. We hope that each and every Friend of the National Zoo will attend the birthday gala to celebrate 30 years of achievement and to dedicate themselves to another 30 years of Friendship. Look for further information in the next issue of *Wildlife Adventures*.

DRAGONS ON DISPLAY

July 13 marked the official opening of the long-awaited Komodo dragon exhibit in the Reptile House. NZP Director Michael Robinson, Smithsonian Assistant Secretary for Research Robert Hoffmann, and Indonesian embassy officials celebrated the opening at a special reception, and Curator of Reptiles Dale Marcellini and Keeper-Leader Bela Demeter presented a lecture about their expedition to acquire the animals. The Komodo monitors arrived at the National Zoo on May 12 and were housed in routine quarantine to ensure their good health before going on



Flowers at the National Zoo. (Photo by Chris James)

exhibit. Transportation for the monitors and their NZP escorts was donated by Garuda Indonesia airlines.

HORTICULTURE TOURS

A brand new tour, featuring the flora rather than the fauna of the National Zoo, will be offered on Saturday, August 20, from nine a.m. to noon. Covering a limited area of the Park, the tour will highlight rare and unusual plants as well as gardening tips and techniques from the Zoo's Horticultural staff. The tour is free, but reservations are required. For further information, call Mary Sawyer Hollander at 673-4955.

RESEARCH UPDATE

About 500 miles off the coast of central Chile, the Juan Fernandez islands suddenly appear—craggy green oases in the vast blue of the Pacific. Isla Santa Clara, Isla Robinson Crusoe, and Isla Alejandro Selkirk (named for the sailor whose real-life marooning in the Juan Fernandez islands inspired Defoe's fictional tale), along with another pair of tiny oceanic is-

lands 500 miles to the north, are the only home of the rare Juan Fernandez fur seal (*Arctocephalus philippii*). These islands also support a very rich flora and fauna, including many endemic species—plants and animals found here and nowhere else. But it was the fur seal that attracted NZP post-doctoral student John Francis, as well as NZP scientists Daryl Boness and Olav Oftedal.

For the past seven years, Boness and Oftedal have been investigating maternal care patterns in pinnipeds, traveling widely to compare these patterns in a variety of species including gray, harp, hooded, and harbor seals; walruses; California sea lions; and Hawaiian monk seals. These superficially similar species display highly divergent maternal care patterns. Female harp seals, for instance, wean and abandon their pups just a few days after birth, while female walruses lactate and care for their pups for as long as two years, with corresponding differences in maternal foraging behavior, fat content of milk, and pup growth rates. Among the fur seals, these patterns seem to vary according to latitude, with sub-polar fur seals showing relatively brief maternal care (three to four months) and



Juan Fernandez fur seals. (Photo by John Francis)

tropical species prolonged care. Little, however, is known about fur seals living in temperate climates so, aside from the allure of being a modern-day Crusoe, Francis joined the NZP pinniped program to study the Juan Fernandez fur seal.

With support from FONZ, the Smithsonian, and the National Geographic Society, Francis is about to set off for his second fur seal breeding season, living off the land on Isla Alejandro Selkirk. His early findings suggest that the maternal strategies of this species combine features of sub-polar and tropical fur seals. For instance, like sub-polar species, the length of lactation is less than a year and milk is high in fat, but, more like tropical fur seals, mothers alternate short, frequent foraging trips with short, frequent periods on land taking care of pups.

Francis is also assisting conservation biologists of the Instituto Antartico Chileno in their efforts to ensure the survival of the fur seals. Nearly exterminated by sealers in the 18th century, this fur seal was believed extinct until a remnant cave-breeding population was discovered in the late 1960s. With total protection, the population on the two island groups now numbers about 7000, but development of the islands for tourism may threaten their recovery, as it also threatens all the unique wildlife of these once deserted islands.

PANDA WATCH '88

At press time, the Zoo community was waiting with crossed fingers for news of a



Recently hatched king vulture (Sarcorhamphus papa). (Photo by Bryon Shipley)



Setting up for the panda watch. (Photo by Jessie Cohen, NZP Graphics)

possible panda birth. Repeating the routine of previous seasons, FONZ volunteers were watching Ling-Ling around the clock for signs of nesting or impending birth. In order to ensure her privacy, volunteers observed the female panda via video equipment generously loaned to the National Zoo by the Sony Corporation and the National Geographic Society. Ling-Ling has been pregnant three times before and has had a total of four cubs, none of which survived for more than four days. Building on past experience, NZP officials made alterations to the exhibit and took other precautions to reduce the presence of infectious bacteria that were implicated in the deaths of previous cubs.

KING VULTURE HATCHING

On April 30, a king vulture chick pecked its way out of the shell and into the Zoo world. The chick is the first of its species to hatch at NZP since 1979, and keepers are pleased that the doting parents are raising their offspring successfully. King vultures in zoos often eat their newly hatched young, and a chick born here in 1979 suddenly disappeared after two days. For this reason, many zoos hand-raise king vulture chicks, frequently producing a bird that identifies with humans and is difficult to manage. Now weighing four pounds, the chick is covered with white, downy feathers that contrast sharply with its naked, black head and

neck. In several weeks, black juvenile feathers will replace the white down and adult coloration will begin in about two years.

—Byron Shipley, Keeper
Bird House

NEW HOSPITAL

In late May, construction was completed for the National Zoo's new veterinary hospital. Featuring state-of-the-art facilities and equipment, the building includes a large operating theater and a radiology unit designed for both large and small animals. The hospital's laboratories will support the medical programs of the Zoo, as well as research in zoological medicine, reproductive physiology, and pathology. The new clinical area provides much easier access for large species and has wards specially designed to house hoofed stock and big, powerful animals. Educational opportunities were also a consideration in the design of the building, which includes conference rooms, offices for visiting scholars, multi-headed microscopes, and a veterinary medicine library. In addition, the hospital has an invertebrate ward, which will allow NZP veterinarians to investigate the health needs of marine invertebrates. Animal health and pathology staff moved offices and equipment into the building during the first weeks of June. Following a year-long renovation, the old hospital will house the Department of Zoological Research.

ALTERNATIVES TO DESTRUCTION

Saving the Tropical Forests. 1988. J. Gradwohl and R. Greenberg. Earthscan Publications, London. 207 pp. \$12.95 paper.

There is every reason to be gloomy about the future of the world's tropical forests. So great is the pace of destruction, and so great is the human need and greed that fuels it, that Zoo Director Michael Robinson, in his preface to this book, suggests that an extraordinary research effort comparable to that of World War II's Manhattan Project is necessary literally to save life on Earth. But all over the globe, people are working on small-scale "finger in the dike" strategies to hold off the flood of deforestation. Descriptions, or case studies, of these promising grass-roots projects are the subject of *Saving the Tropical Forests*.

The 38 case studies, all of projects in lowland moist tropical forests, fall into four broad categories: Forest Reserves; Sustainable Agriculture; Natural Forest Management; and Tropical Forest Restoration. The projects range from indigenous people working to save their pristine ancestral lands from colonization, to iguana ranching, development for wildlife tourism, and re-growing patches of tropical forests. What they have in common, however, is that all of these successful or promising forest conservation projects also serve primary human needs.

The iguana ranching project in Panama, for instance, was designed to introduce captive-bred green iguanas, which had been virtually extinguished through over-hunting for food and habitat destruction, into deforested areas at the same time as useful trees were planted. The iguanas will essentially be managed in the wild, with the iguanas feeding on the leaves of the planted trees, and people then harvesting the iguanas and the fruit. At the same time, cut-over land is being reforested, and equally important, intact forest is not degraded to ranch some other protein source such as cattle. Thus, the "vision of hope" that this book provides is not just for the future of forests and wildlife, but for the future of people. And, as these case studies show, conservation that works is conservation for people, not against people.

This book grew out a conference held at the National Zoo in 1985, sponsored by the Smithsonian, FONZ, and World Wildlife Fund-US, and was published in conjunction with the new Smithsonian exhibit, "Tropical Rainforests: A Disappearing Treasure," which can be seen in the International Gallery of the S. Dillon Ripley Center.

—Susan Lumpkin

FLYING IN

A new creature has landed in the Zoo, right smack in the middle of the Education Building. But it won't be needing much care or cleaning, nor is it likely to disturb Zoo or FONZ employees working in the building—because it's been extinct for about 64 million years. It's a half-scale model of a pterodactyl (*Quetzalcoatlus northropi*) boasting an 18-foot wingspan. But the model isn't just another pretty reptile. Its realistic wings have actually carried the replica flapping above the salt flats of Death Valley, California. The pterodactyl was conceived in 1984, when the National Air and Space Museum commissioned Dr. Paul B. MacCready, chairman of AeroVironment, Inc., to build a working model. The Smithsonian hoped the project would increase knowledge in the fields of aerodynamics and paleontology, and also wanted to star the pterodactyl in their film "On the Wing," can be seen at the NASM.

The model, the first working flying machine with flapping wings, had to have help on take-offs, but once launched, it flew by flapping its battery-powered

wings. The batteries stored enough power for five-minute-long flights. Because the beast had no tail, it stabilized and steered itself by continuously wagging its large head and moving its wings forward and backward. On the model, an autopilot controls these movements. Its several flights above Death Valley in 1985 were captured for the film. Unfortunately, it later crashed during a demonstration flight at Andrews Air Force Base. Now, after an up and down career, it will spend its retirement years at the Zoo.

KEEPER'S CORNER

While working with red pandas, I found few people outside of the Zoo had even heard of these beautiful, "other" pandas. I was still taken aback, however, when a fellow bus passenger read over my shoulder the title of the book I was carrying—the Red Panda Daily Record Book—and after a moment's thought asked, "Red pandas—aren't they a militant political group?"

—Mary T. Shaughnessy, Intern
Department of
Zoological Research

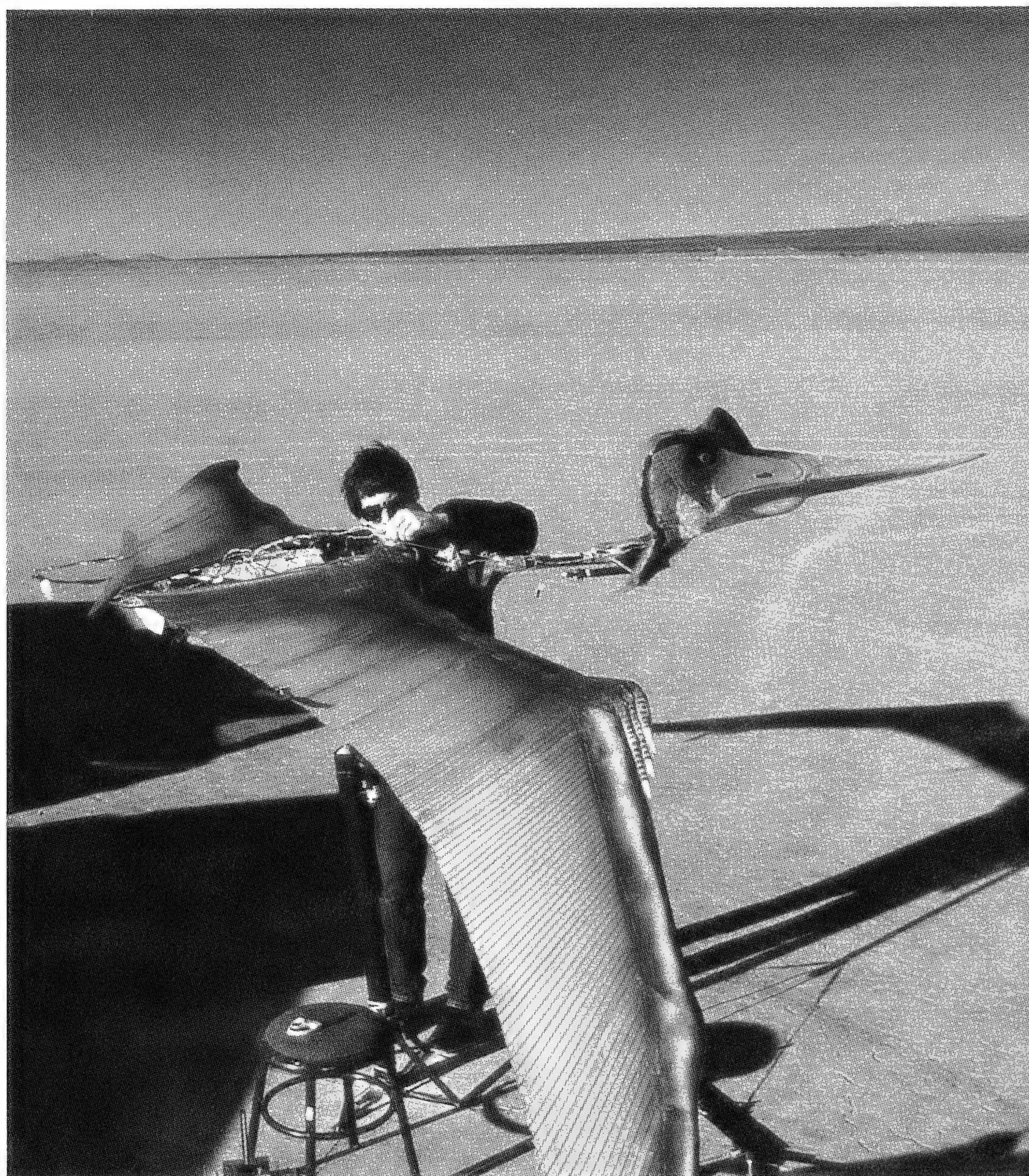


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Hippos At Large

Barbara Sleeper

From the vantage of a steep bank, the waters of the Luangwa River in Zambia seemed still. Distracted, I watched hundreds of colorful carmine bee-eaters swoop in and out of their riverbank nests. Suddenly, the explosive sound of an exhaled breath drew my attention back to the water just as the wiggling ears, bulging eyes, and valve-operated nostrils of a hippopotamus broke the surface. The members of an entire group of hippos, which had been concealed under the serene water, then revealed themselves. Each surfaced, exhaled, inhaled—then sank out of sight. Only a few kept their eyes above the surface to watch me watching them. Perhaps to warn me of just how much animal a pair of eyes represented, one hippo emitted a loud, deeply resonant grunt. This distinctive sound, heard day and night in the African bush, could only be produced by a *big* animal.

With adult males tilting the scales at two to three tons, the common hippopotamus (*Hippopotamus amphibius*) rivals the white rhinoceros as the third largest extant land animal (after the two species of elephant). A mature bull may measure 12 feet from nose to tail and stand nearly five feet tall at the shoulder. The hide alone of this thick-skinned beast can weigh a half-ton. The pygmy hippopotamus (*Choeropsis liberiensis*) is small only in comparison, weighing up to 600 pounds and standing three feet tall.

Hippopotamuses (from the Greek for “river horse”) are even-toed ungulates whose closest taxonomic relatives are pigs. First appearing in Africa about 20 million years ago, hippos had radiated into Europe and Asia by about two million years ago. These early hippos, of which there were several species, are believed to have been largely forest dwellers, more similar to the modern forest-living pygmy hippo than to the more specialized common hippo. In the late Pleistocene, however, the common hippo was widely distributed in Africa and Europe, reaching as far as northeastern England before retreating to warm climates with the com-

ing of the last glaciation about 75,000 years ago.

Today the two remaining species of hippos are confined to Africa, where the pygmy hippo survives only in the dense interior forests and swamps of Liberia, Ivory Coast, Sierra Leone, and Guinea. Little is known about this primitive hippo in the wild, but it appears to be more solitary (a mother and her single offspring are the only social groups) and less aquatic (its feet are less webbed) than the common hippopotamus.

River Horses

The common hippo lives along lakes, swamps, and slow-flowing rivers in grasslands from south of the Sahara down into South Africa and in the interior of Central Africa. In social herds of 15 or more individuals, the semi-aquatic hippos pass the day dozing in the water or wallowing in mud holes. Good swimmers and divers, hippos can hold their breath for up to five minutes, and even when they come up for air need expose little beyond their eyes, ears, and nostrils which are located high atop their heads. A high specific gravity also means that hippos can walk, completely submerged, along the beds of shallow lakes and rivers.

Hippos even mate in the water—often with the female submerged. Mating occurs during the dry season when hippo populations are concentrated at water sources, and births follow about eight months later during the rainy season. Just prior to giving birth, a female hippo separates from the herd and lies on her side in the water for labor. The single offspring (twins occur rarely) is often born underwater and must swim to the surface for its first breath of air. Young are also nursed underwater.

The blue-gray color of the hippos' thick skin camouflages them in the water during the day. What at first appears to be a group of slowly floating logs frequently turns into a small group of submerged water horses snoozing and snorkeling the day away, expending as little energy as possible. For while hippos

spend most of the time in water, they eat only on land and do all their feeding during five or six hours of the night.

After sundown, hippos emerge from the water and nimbly climb up steep riverbank trails that lead to inland grazing. These hippo paths are deeply rutted by repeated use and are marked by dung piles that may serve as scent posts for orientation at night. Running up to two miles in length, trails lead to areas of short grass where a hippo may eat 80 to 100 pounds of vegetation in an evening. True herbivores, hippos are efficient grazers. Using their tough, mobile, 20-inch wide lips, they are capable of clipping grass as neatly as sheep do. Before sunrise, the hippos return along their trails to spend yet another lazy day in the safety of the water.

The hippos' skin is responsible for these animals using different habitats for day versus night, for breeding versus feeding. A thick dermis, typical of aquatic mammals, is covered by a smooth, thin outer layer of skin that acts like a wick for the transfer of water. When exposed to the air, the skin thus permits a very high rate of water loss—three to five times the rate of water loss through human skin. Lacking sweat glands to help regulate body temperature, hippos are unable to vent excess heat through the skin while also maintaining a stable moisture balance. This means that hippos easily overheat on a warm day unless they have frequent access to water. To help protect the skin from desiccation, hippos' pores secrete a red, viscous fluid. This highly alkaline secretion builds up into a pink lather along a hot hippo's head and neck until the animal can cool off in water. P.T. Barnum used this phenomenon to entice patrons to his circus extravaganzas by promoting the notion that hippos “sweat blood.”

Adult hippos have few natural enemies, being well armed with continuously growing canines that form long, curved tusks hidden by the fatty inner edge of their lips. Crocodiles are seen feeding on hippo carcasses, but these are

probably the victims of poachers—or of battles between hippos—rather than of crocodile predation. In fact, in the Mara River of Kenya, hippos wade in close proximity to large Nile crocodiles basking on sandbars, and I saw hippos swimming, dozing, and wading quite complacently with yards of the powerful reptiles.

Young hippos, however, do fall prey to crocodiles as well as to lions, leopards, hyenas, and wild dogs—and females are thus extremely aggressive in protecting their offspring. Young are usually sheltered on the side of the mother farthest from old bulls and other dangers. In the water, calves, although capable of walking and running within five minutes of their birth, spend most of their time hidden from view while the female keeps a careful watch. A baby hippo often crawls up onto its mother's back as she rests in the water, a behavior that has been interpreted as an anti-crocodile tactic, although it could also simply be play or resting behavior.

Young aren't the only animals that hitch rides on hippos. Young crocodiles and terrapins can be seen basking on the backs of sedentary hippos, and cattle egrets and hammer-headed storks use hippos' backs as fishing perches. Below, cyprinid fish graze on the algae that grows on the hippos' skin. Not quite so

harmless are parasitic flukes that are found attached to the eyes of most wild hippos.

Hippo History

Hippos have fascinated people for centuries. They were a regular attraction in ancient Rome, where they were pitted against other wild animals in Colosseum contests. Emperor Augustus imported the first hippo into Europe in 29 B.C. for his personal menagerie. The Viceroy of Egypt sent a hippo to the Zoological Gardens of London in 1850 and ever since hippos have been popular animals in zoos in Europe and America. The National Zoo first exhibited a hippo in 1911 and hippos have been continuous inhabitants of the Zoo ever since.

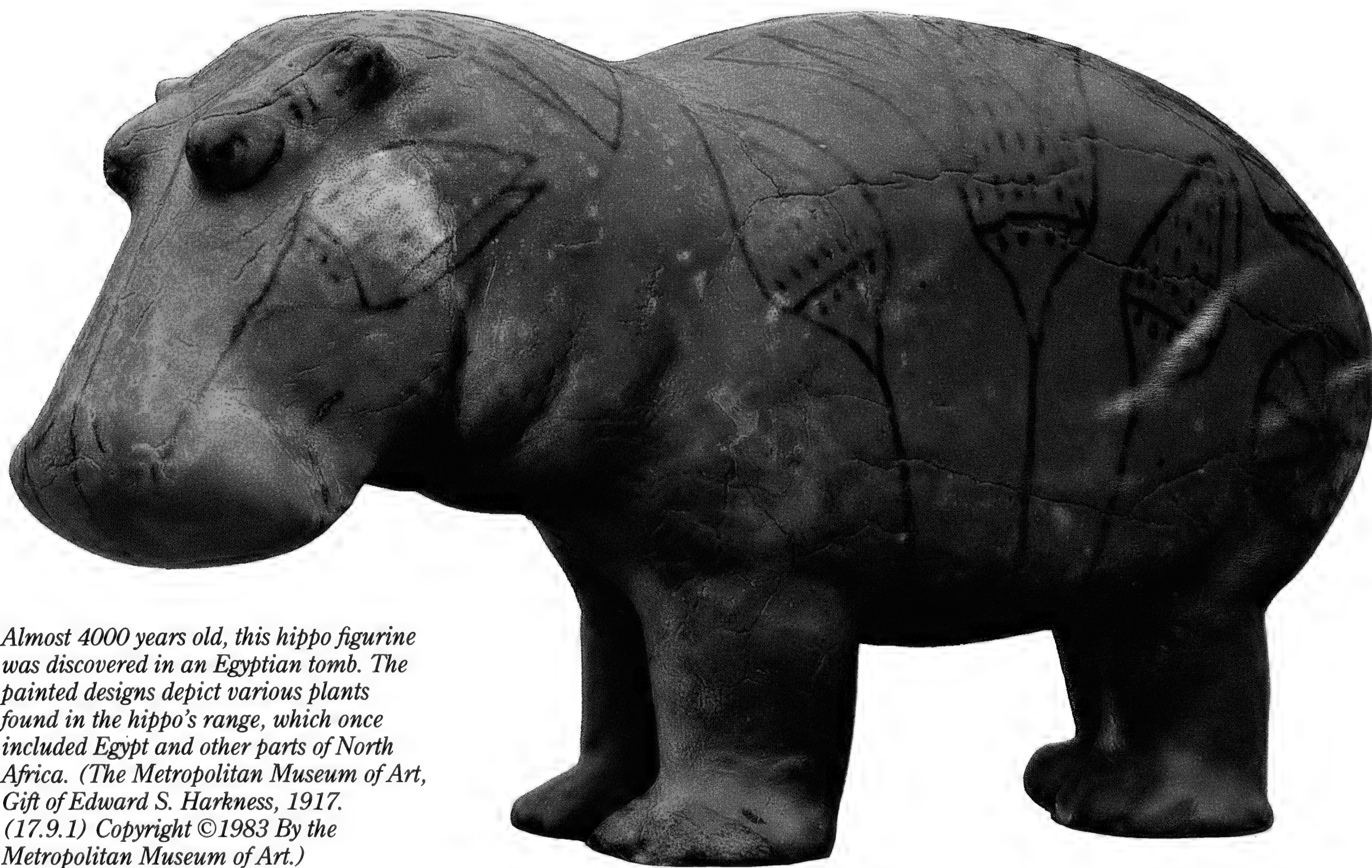
It is probably the hippos' lethargic daytime behavior coupled with their size and bulbous shape that has given rise to the common cartoon images of the hefty beast. Portly hippos have been comically portrayed walking tightropes and standing erect in Sunday dress carrying parasols. Cute and cuddly hippos—from stuffed toys and T-shirts to diet spoofs and greeting cards—can be seen everywhere. Yet this popular image is misleading.

Several years ago at Seattle's Woodland Park Zoo, a woman apparently taken

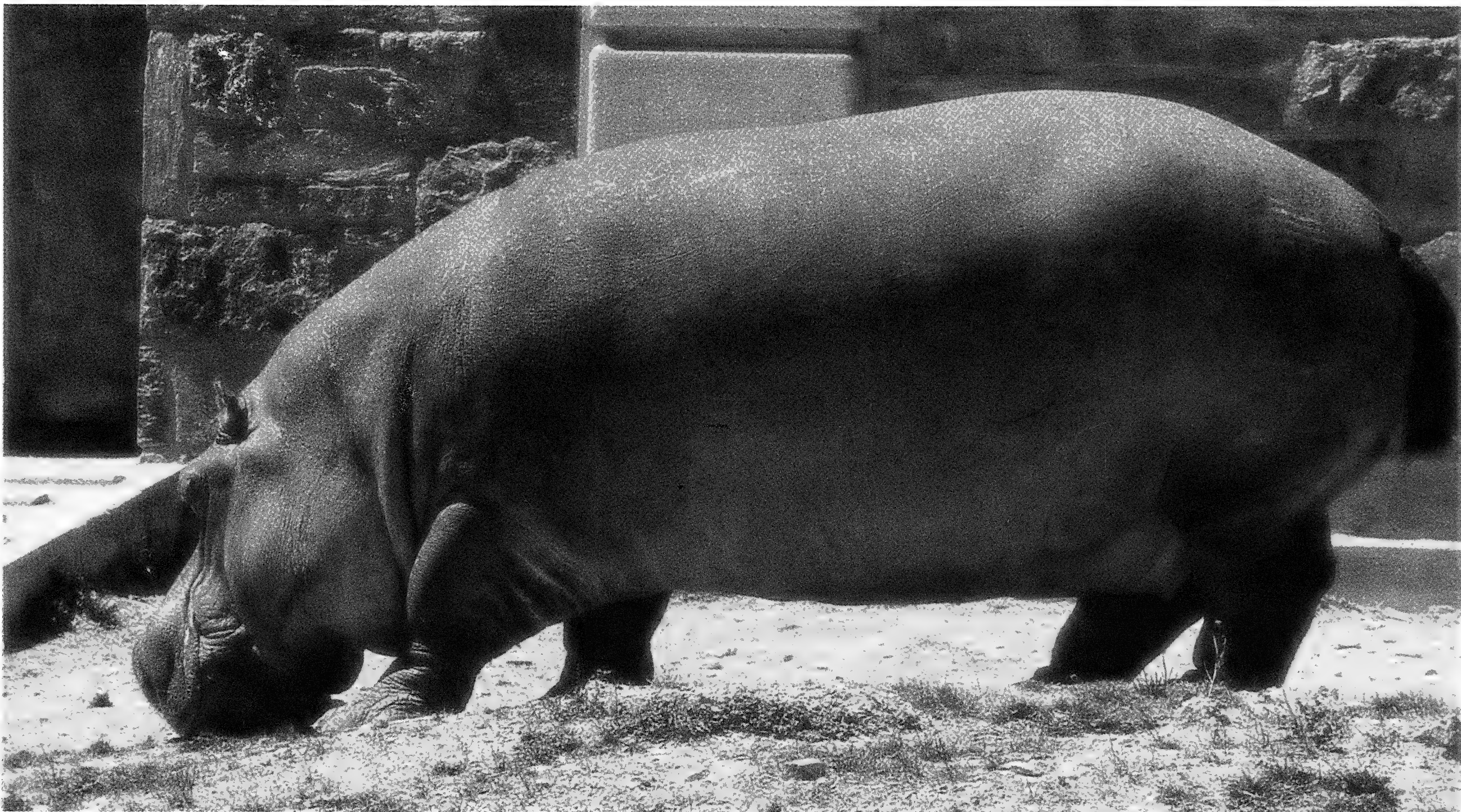
in by the hippo's popular image climbed a fence and jumped into the hippo pool. Fortunately, she was literally washed out of the pool on the tidal wave created when the feisty female hippos charged in after her.

In the wild, as in zoos, hippos are aggressive and unpredictable. Indeed, by some accounts, hippos kill more people in Africa than any other wild animal does. They can outrun a man on land for short distances and have been known to attack and kill people who inadvertently block their access to water or get between a mother and calf. Both male and female hippos threaten intruders by throwing back their heads and opening their cavernous mouths in a yawning display of tusks. This seemingly innocent yawn is actually the first sign of an agitated hippo. Following the yawn, the hippo repeatedly opens and closes its mouth, all the while uttering low grunts and bobbing its head. If this warning is not heeded, the hippo may well attack. Cantankerous hippos have made unprovoked attacks on small boats, splintering wood and puncturing inflatable rafts when they suddenly erupt from the water with an impressive display of pink, gaping mouths and gnashing tusks, and on tourists who attempt to get too close.

People, however, are also a menace to

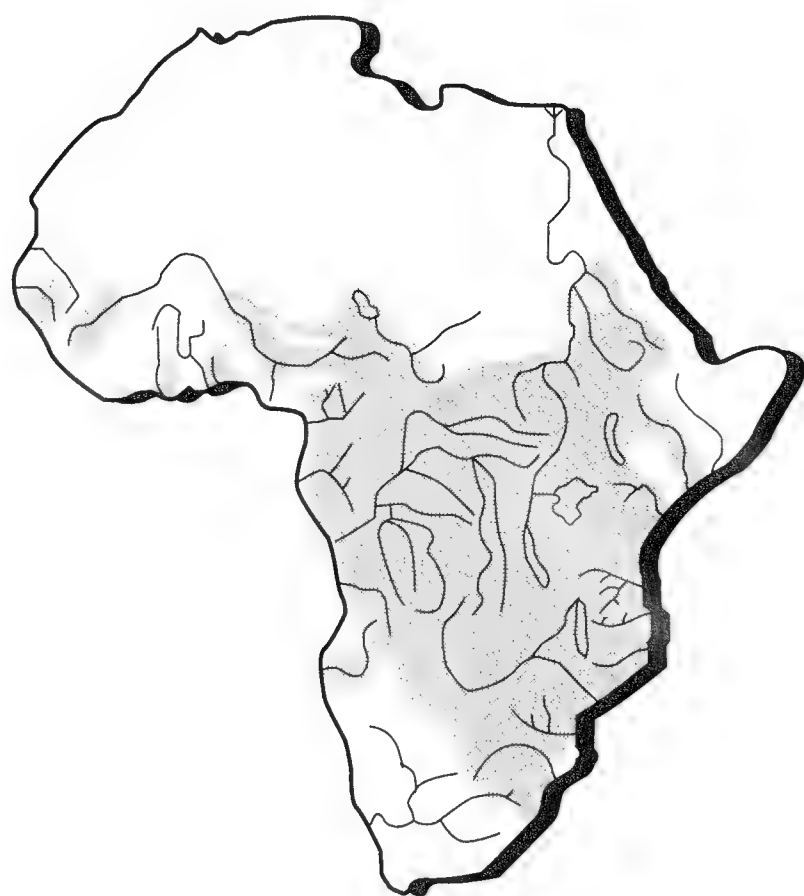


Almost 4000 years old, this hippo figurine was discovered in an Egyptian tomb. The painted designs depict various plants found in the hippo's range, which once included Egypt and other parts of North Africa. (The Metropolitan Museum of Art, Gift of Edward S. Harkness, 1917. (17.9.1) Copyright ©1983 By the Metropolitan Museum of Art.)



The Zoo's young male hippo was born here in 1981—the 21st offspring of his prolific mother, who came to the Zoo from Tanzania in 1955. (Photo by Chris James)

hippos. Hippos are a good source of large quantities of meat, their tusks provide ivory, and their hides can be made into tough leather. Archaeological finds in Africa indicate that prehistoric men dug pits along hippo paths, lining them with



Hippopotamus distribution in Africa.

pointed spikes and harpoon-like weapons to capture the animals. Early humans hunted hippos with stone weapons in Europe's Seine and Rhine river valleys. And more recently, machine guns were used to slaughter whole herds of hippos in Uganda during the civil unrest associated

with the overthrow of Idi Amin.

Despite all of this, and as well as their being very unpopular with farmers who wake to find their planted fields devastated by grazing hippos, hippos seem to be holding their own in much of sub-Saharan Africa. While their range has been greatly reduced by human activities, in some areas hippos are considered at various times "locally overabundant." To prevent their raiding farms or overgrazing natural habitat, these large hippo populations are often culled. Remarkably, however, hippo numbers quickly increase following these deliberate reductions. Even Uganda, where hippos were virtually eliminated just 10 years ago, has good numbers of hippos today.

In large measure this is due to the pressure on hippos being sporadic, unlike the relentless and nearly uncontrolled poaching for ivory and horn that has driven Africa's elephants and rhinos close to extinction. But hippos also appear better able than these species to rapidly increase their numbers.

Remarkably free from disease and hardy in the face of temporary food shortages or drought, hippos live from 20 to 40 years in the wild and almost 50 years in zoos. More important, for an animal of this size, hippos have a relatively high rate of reproduction. Gestation, for instance, is only about eight months, compared to 22 months for elephants and 15

to 18 months for the larger rhino species. Moreover, female hippos are capable of producing an infant yearly under favorable conditions. The Zoo's female bore 21 young in as many years, and studies of wild hippos showed that about 10 percent of females with infants are already pregnant again. In contrast, even under good conditions, female elephants give birth only every three to four years and rhino births are usually spaced two to four years apart.

Hippos are also great wanderers, moving along watercourses or cross-country during the rains to colonize new areas of suitable habitat. Hippos can survive in small, remote lakes in arid country and are even found on two small islands off the coast of East Africa. Thus while hippos are legally protected wherever they occur in Africa, the common hippo is not considered to be in any danger. Nonetheless, the future of all of Africa's wildlife seems precarious at best, and based on the hippo's large size alone, it is difficult not to fear that it may only be a matter of time before one more magnificent megavertebate begins to succumb to modern man. □

Barbara Sleeper is completing a Ph.D. in animal behavior at the University of Washington; she became interested in hippos by watching their behavior at the Woodland Park Zoo in Seattle.

Going to Pieces

Robin Meadows

A new mall paves over a wetland, a commuter road cuts through the heart of a suburban park, a wooded estate is plowed under for tract housing. Wherever development dollars push suburban sprawl to the limits of profitability, money talks and wildlife——?

More often than not these days, wild animals cannot simply pick up and move. Why? While the wholesale destruction of habitats is obviously devastating to wildlife, the long-term impact of “nicer,” less drastic development—logging roads, farm fields, and houses on large acreage—fragments the remaining wilderness and, over time, may seal the fate of surviving wildlife.

Breaking up a wilderness fragments not only habitats but animal populations as well, dividing large groups of animals into many smaller ones. In many cases, these groups become prisoners of their habitat patches, physically unable or unwilling to abandon the protection they afford to cross the man-made landscapes that separate pockets of habitat. Once so isolated, wild animal groups—like some small collections of zoo animals—may lack the genetic diversity needed to keep their populations healthy. And of course, small, boxed-in populations are easily wiped out by floods or fire.

Despite strong hunches, conservationists battling unsound development up to now have had little hard evidence that animals confined to habitat patches are at risk (and in court, where an increasing number of development wars are waged, facts and figures are everything). But two recent studies have shown that animals do indeed suffer rapid extinction in fragmented habitats, both urban and rural: The first study focused on birds living in canyons isolated by development in San Diego; the second looked at mammals in national parks of the American West.

California's San Diego County contains a maze of steep canyons that until recently preserved a remarkable network of chaparral habitat in an otherwise urban setting. Unique to the West, the chaparral, with its low, scrubby vegetation, is



Even expansive parks, like Montana's Glacier National Park, may become isolated islands unless bordering development is carefully monitored. (Photo by Milton Tierney)

home to more than 20 species of birds and is key to the lifestyles of such ground-dwellers as the quail and roadrunner. Where these networks are intact, birds can travel long distances without leaving the protection of the sagebrush scrub. Indeed the roadrunner's trademark response—it flees rather than flies in the face of danger—is one example of

how birds depend on this unique habitat for moment-to-moment survival as well as for food and breeding areas.

Unusual as it is, this system within a system could not withstand the twin pressures of rising real estate values and engineering ingenuity: Once too steep for profitable development, San Diego's canyons in recent years have been filled and

terraced for building sites, while new highways and interstates have been routed through many of the larger canyons and valleys. The resulting fragmentation of the canyon system directly affected the lives of birds that neither migrate nor tend to fly from place to place; with their dispersal routes cut off, the county's ground-dwelling birds became isolated in

birds it supported. Most species disappeared within a few decades of canyon isolation, even though recently isolated canyons still contained many bird species. Soule' therefore concluded that these populations become extinct faster when their environment is broken up. While larger canyons generally had more species of ground-dwelling birds, popula-

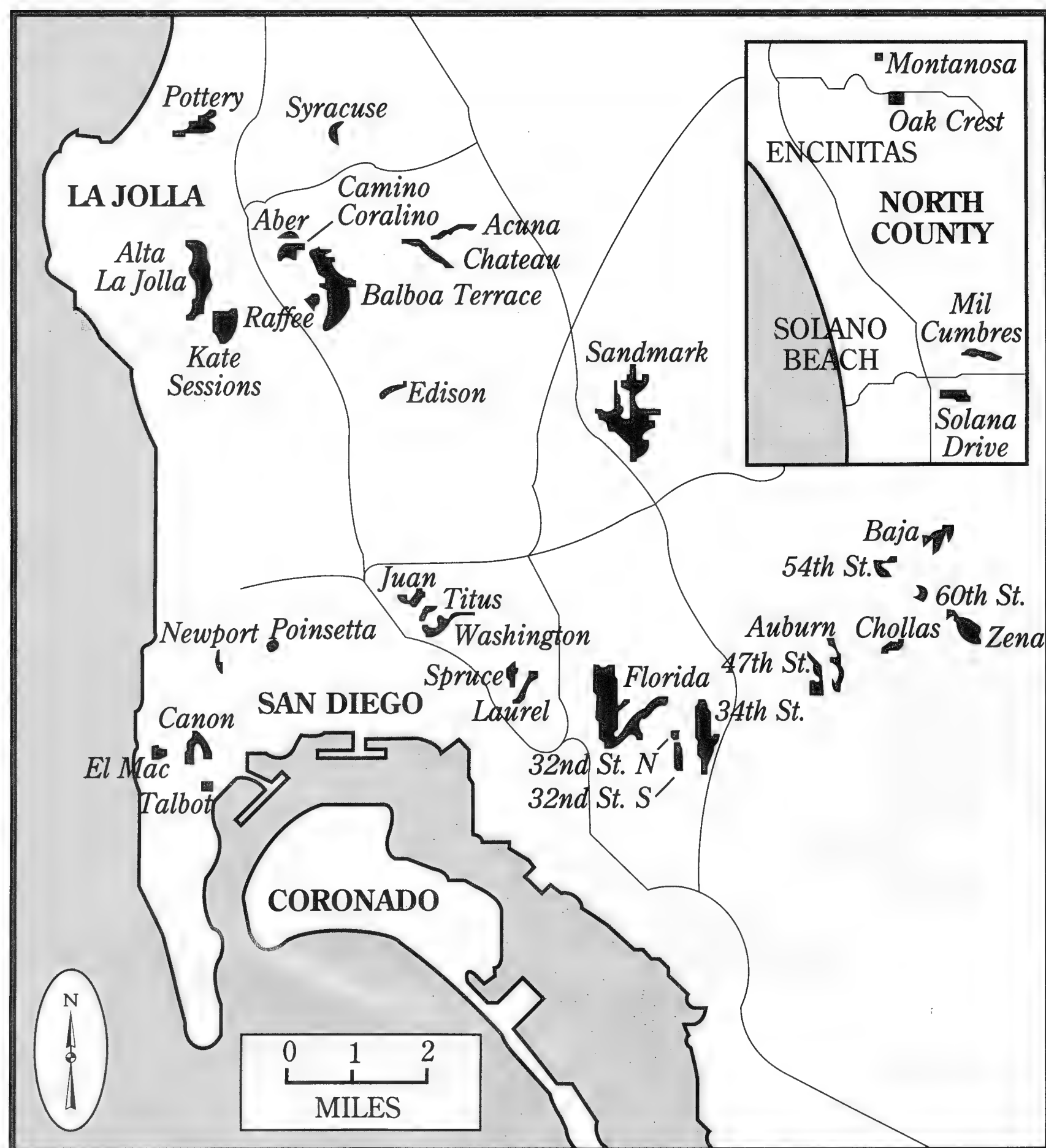
scrub will be lost from San Diego canyons within the next 90 years, Soule' predicts.

Soule' further suspects that ground-dwelling birds die out because coyotes leave isolated canyons. While coyotes eat an occasional bird, they also prey on gray foxes and other small animals that frequently eat birds. By keeping predators in check, coyotes may actually protect birds, so their disappearance may pose a further threat to bird populations.

Extinction is not inevitable, however. Species could be reintroduced to cut-off canyons, Soule' suggests, and urban developers could leave "corridors" of chaparral scrub to connect otherwise isolated canyons. Traveling from canyon to canyon would allow birds to breed within a larger population and increase the genetic diversity of their offspring. Such corridors would also enable wildlife to escape local disasters and encourage coyotes to move freely. Indeed the development or preservation of similar "greenways" (under highways or along power line rights-of-way, for example) could help save animals in the wild areas of any city.

The finding of the San Diego study—that populations restricted to small habitat patches rapidly become extinct—is not too surprising. Wildlife preservation in the face of an economic boom was not a priority for local government, hardly a unique situation these days. More shocking, however, was the recent discovery of a similar phenomenon in an area where we generally pride ourselves on doing a good job for wildlife—those large habitat patches that make up our national park system.

Biologist William Newmark, formerly of the University of Michigan and now of Tanzania's College of African Wildlife, studied extinctions of mammals in 14 western and Canadian national parks, ranging from Utah's Bryce Canyon, 60 square miles in size, to an 8000-square mile area of four contiguous parks that border the provinces of Alberta and British Columbia. Concentrating on rabbits, hoofed animals, and carnivores, Newmark searched park records for past sightings and considered a species to be locally extinct if no sighting had been noted in the previous decade. His research revealed that since the foundings of the various parks, a total of 23 species had disappeared: five different species of rabbits; four hoofed mammals, including pronghorn antelope and moose; and 14 carnivores, including weasels, bobcats, and wolverines. With the exception of the two largest parks, at least one species of mammal had died out in each of the parks studied, and the smaller the park, the greater the number of species that



Map showing the location of the study sites (canyons) in the vicinity of San Diego, California. Adapted by permission of the publisher and author. Conservation Biology, March 1988.

a number of small populations.

Taking advantage of San Diego's unplanned "experiment," conservation biologist Michael Soule' decided to take a close look at how habitat fragmentation affects the survival of ground-dwelling birds. Working with students from the University of California, San Diego, Soule' studied 37 isolated canyons, which ranged from one to 257 acres in size and from two to 86 years in "age"—measured as the time since the canyon was cut off by a road or subdivision.

Soule' found that the older the canyon (that is, the longer it had been cut off), the fewer the species of ground-dwelling

tions eventually died out even in the largest canyons. Based on the current rates of extinction, Soule' estimates that San Diego's canyons will lose virtually all ground-dwelling species in the next 100 years.

While loss of genetic diversity and mobility are taking their toll on birds, the extinction process is also driven by the fact that natural canyon vegetation is itself disappearing. Trampled by people walking through or playing in the canyons and overrun by alien plants "escaped" from nearby gardens or deliberately introduced for ornamental or fire-retardant purposes, the fragile native

had become extinct. Thus Newmark concluded that virtually all the parks he studied are too small to support populations of many native mammals.

Yet it seems absurd that our national parks, long idealized as pristine havens for wildlife, should be losing species. Why is this so? The increasing disturbance of land *surrounding* the parks is largely to blame, Newmark believes. For example, people hunt near parks, making outside animals less likely to cross a danger zone and thus unavailable to replenish the protected population. Private property, motels, and recreation sites often abut park boundaries; when vegetation is cleared to make way for human structures or activities, an invisible barrier is created, in effect “fencing” animals into or out of the park. Such disruption stops the flow of animal traffic in both directions, with consequences for wildlife on both sides of the border.

While experts agree that habitat fragmentation threatens the world’s wildlife, they disagree about how to prevent extinctions in habitat patches—and many species exist in the wild only in such patches, be they parks or other protected areas. Because these areas essentially serve as wild zoos, reserve managers may need to adopt zoo management techniques, such as exchanging animals on breeding or permanent loans.

For instance, Newmark proposes a two-track approach to stemming the loss of wild species. Park wildlife should be managed more actively, he suggests, with approaches ranging from population monitoring to inter-park animal exchanges or reintroductions. Second, the federal government, which owns 85 percent of the property bordering national parks, should create buffer zones of undisturbed lands to enlarge parks and enable them to support larger, more diverse animal populations.

But according to James Quinn, a conservation biologist at the University of California, Davis, bigger reserves are not necessarily better. Diversity of habitats and the number of populations of a given species in a protected area are also critical factors in conservation efforts. While large parks are undeniably important for preserving animals with large home ranges, Quinn cautions that small habitat patches also play an essential role for other species.

Preserving more types of habitats will protect more kinds of animals, while protecting more populations will make that species more likely to survive. In other words, Quinn believes that the sum of several small parks may be greater than a single, whole park of equivalent area for some types of animals.

To test his hypothesis, Quinn com-

pared the number of species in large and small western national parks. The two largest parks accounted for half the study area, while a combination of 22 smaller parks comprised the other half. Indeed, Quinn found that the pair of large parks contains less than half of the 164 species protected in the national parks he studied, while the collection of small parks

resources, Quinn recommends preserving unique habitats and species not protected elsewhere, in small or large parks as appropriate.

While conservation experts may dispute means, they agree on the desired end: to protect the world’s remaining wildlife before time runs out completely. The obstacles to achieving this—from



Wolves (Canis lupus) and other carnivores have gone extinct in many national parks as a result of habitat fragmentation. (Photo by Jessie Cohen, NZP Graphics)

contains all but one of the species. Thus, taken together, the small habitat fragments in the study protect a greater number of mammal species more effectively than the large ones do.

In this case, Quinn attributes the result to the diversity of habitats found in this particular collection of small parks. A very large park may protect relatively few kinds of habitats, such as forests and lakes, which are typically found in the same ecosystem. But other environments such as deserts, marshes, and alpine meadows can be so far apart that several parks would be required to protect them all. Given limited conservation

federal budget cuts to the profit motives of short-sighted developers—are difficult enough to surmount in our highly advantaged society. If economic privilege and a relatively strong community of environmentalists cannot buy protection for American wildlife at home, how can we hope to reverse the trend in poor nations, where the choice is too often between bread today and wildlife tomorrow? Commitment from the wealthy nations must be part of any conservation solution in the developing world; not only are we failing to make such a commitment, too often we are failing even to set a good example in our own backyard. □

Seminal Rivalry

Robin Meadows

"With animals having separated sexes there will in most cases be a struggle between the males for possession of the females. The most vigorous individuals...will generally leave the most progeny. But success will often depend on having special weapons or means of defense, or on the charms of the males; and the slightest advantage will lead to victory."

—Charles Darwin

Ever since Darwin, the clashing antlers of rutting deer stags, the bellowing charges and counter-charges of bulls, and even the strutting of brilliantly plumed peacocks have been recognized as examples of the fierce competition between male animals to father as many young as possible. Darwin's theory of evolution by sexual selection, and all modern refinements of it, predicts that in general males will compete with other males for access to females and the opportunity to sire young. The males of many species, from horned beetles to one-horned rhinoceros, adopt the obvious strategy of fighting to win females, and in many others, males may compete among themselves through variation in their attractiveness or the attractiveness of their territory to the females of the species.

In the last 20 years, however, sociobiologists have discovered that males in a diverse array of species take a more subtle approach to beating out their competitors in the contest to father the most offspring—they let their sperm do the competing. Instead of fighting rival males directly for females, these males try to displace or dilute their rivals' sperm.

Competing with sperm is common in primitive marine species such as sea urchins and clams. In these animals, males and females simply shed their gametes into the water, so the more sperm a male produces, the greater his chances of siring offspring. In contrast to such marine animals, many terrestrial species reproduce by internal fertilization. Because internal fertilization places the sperm so close to the eggs, biologists had long assumed that land animals did not compete with their sperm. In fact, some biologists

hypothesized that internal fertilization evolved to circumvent sperm competition.

However, in 1970 entomologist Geoff Parker of the University of Liverpool recognized that sperm competition exists in insects. Female insects often mate with more than one male, and Parker showed that the last male to mate with a given female usually fertilizes most of her eggs.

This strategy for fathering young suits a male insect perfectly because he produces a discrete packet of sperm, which the female then stores in part of her reproductive tract (called the spermatheca). If male mates with a female that already has a sperm packet in her spermatheca, he can displace that packet with his own.

When locusts mate, for example, the male extends a tube from his sperm packet directly into the female's spermatheca. Then, by contracting his abdomen, the locust pumps in his sperm and flushes out his rivals' sperm. When a female locust mates with more than one male, the last male fertilizes more than 85 percent of her eggs.

One way scientists determine the degree of sperm competition between male insects is to let a female mate first with a normal male and then with a second male with irradiation-damaged sperm. If the second male's sperm displace those of the first male, then most of the eggs will be sterile.

Such experiments have demonstrated that sperm competition occurs in almost 20 species of insects, including fruit flies and stinkbugs. In several insects, the last male to mate wins the sperm competition completely. For instance, the last male swallowtail butterfly to mate with a fe-

male fertilizes virtually all of her eggs.

Like insects, female birds store sperm in their reproductive tracts, making the males good candidates for sperm competition. Unlike insects, most birds are monogamous and a paired female usually resists mating with an outside male. Nevertheless, when given the chance a male bird will try to mate with a female in another pair.

While extra-pair matings have been seen in birds from pelicans to sandhill cranes, male ducks are notorious for forcible matings. A male green-winged teal waits until his female is incubating her eggs, and then pursues unguarded females that have not yet laid their eggs. In his frenzied attempts to mate, the male teal may exhaust or wound the unlucky female who tries to escape by flying, diving or hiding in nearby plants.

That male birds so readily try to cuckold each other suggests that sperm competition is widespread among birds. While only a few species have been tested experimentally, in each case outside males do indeed father a significant number of young.

The best evidence for sperm competition in birds comes from analyzing the blood proteins of young from a single clutch. When only the paired male mates with his female, the nestlings all have the same blood proteins. However, when an outside male has also mated with the female, some of the nestlings have different blood proteins.

By such analysis, biologist David Westneat of the University of North Carolina has shown that in indigo buntings, outside males father up to 40 percent of the nestlings. Similarly, in a group of barn swallows, although only seven per-

cent of the observed matings involved outside males, they fathered more than 25 percent of the nestlings. This is possible because females lay several eggs and it suggests once again that, as in insects, the second male bird to mate displaces most of the first male's sperm.

In contrast to insects and birds, most female mammals have no sperm storage organs so the best male mammals can do is dilute their rivals' sperm. At first glance, sperm competition by dilution rather than displacement would seem to be far less efficient. However, experiments in rodents such as hamsters have demonstrated that the two strategies are almost equally effective.

The hamster experiments are similar to the insect experiments. Donald Dewsbury of the University of Florida, Gainesville, found that when a golden female mates first with a golden male and second with a cream-colored male, about 70 percent of her offspring are cream-colored. Thus, as in insects and birds, the last male to mate fathers most of the young.

Because such experiments would be difficult to perform in many species, there is no direct evidence for sperm competition in most mammals. However, there is indirect evidence. Male mammals can be divided into two groups: those with small and those with large

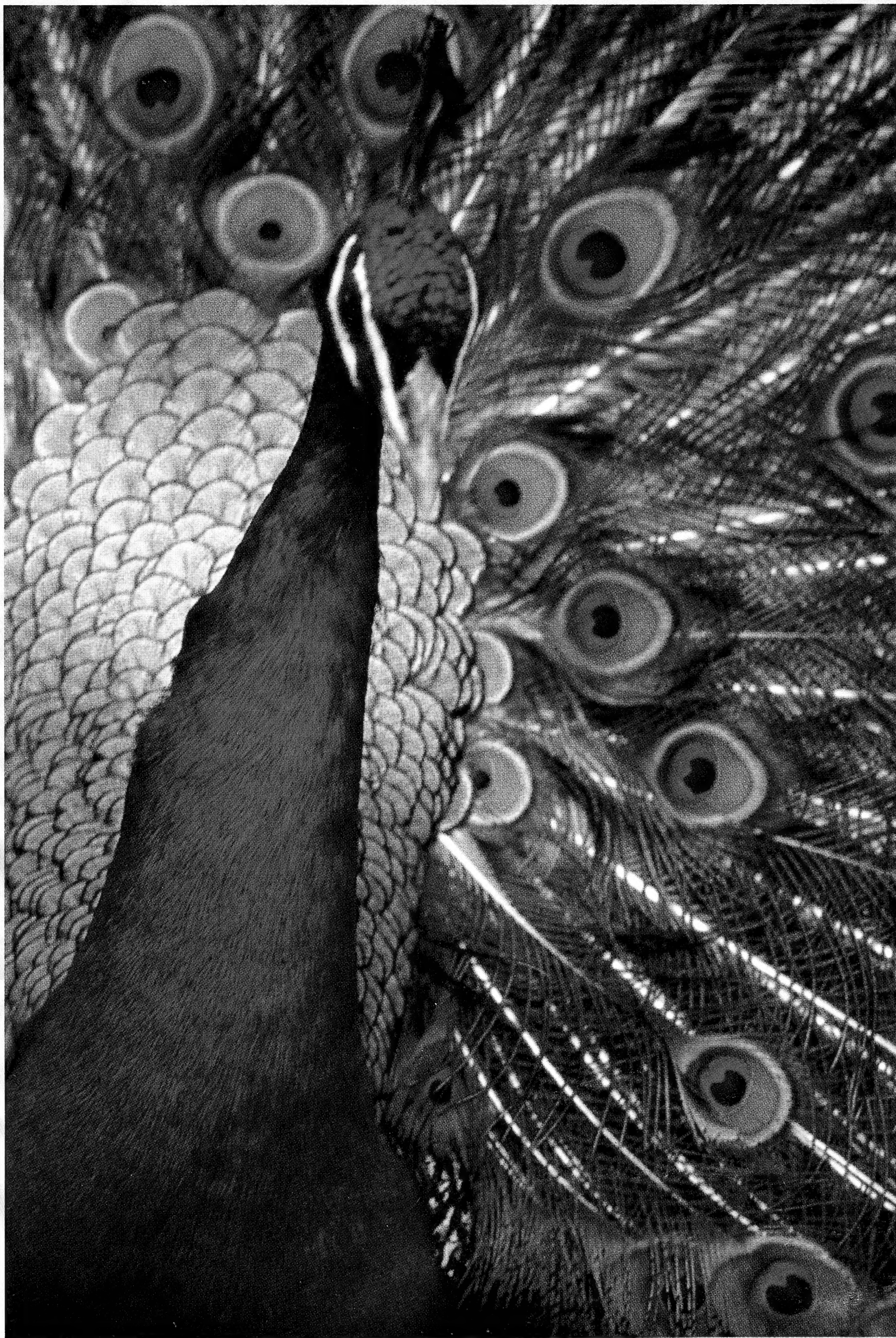


PHOTO BY PAT VOSBURGH

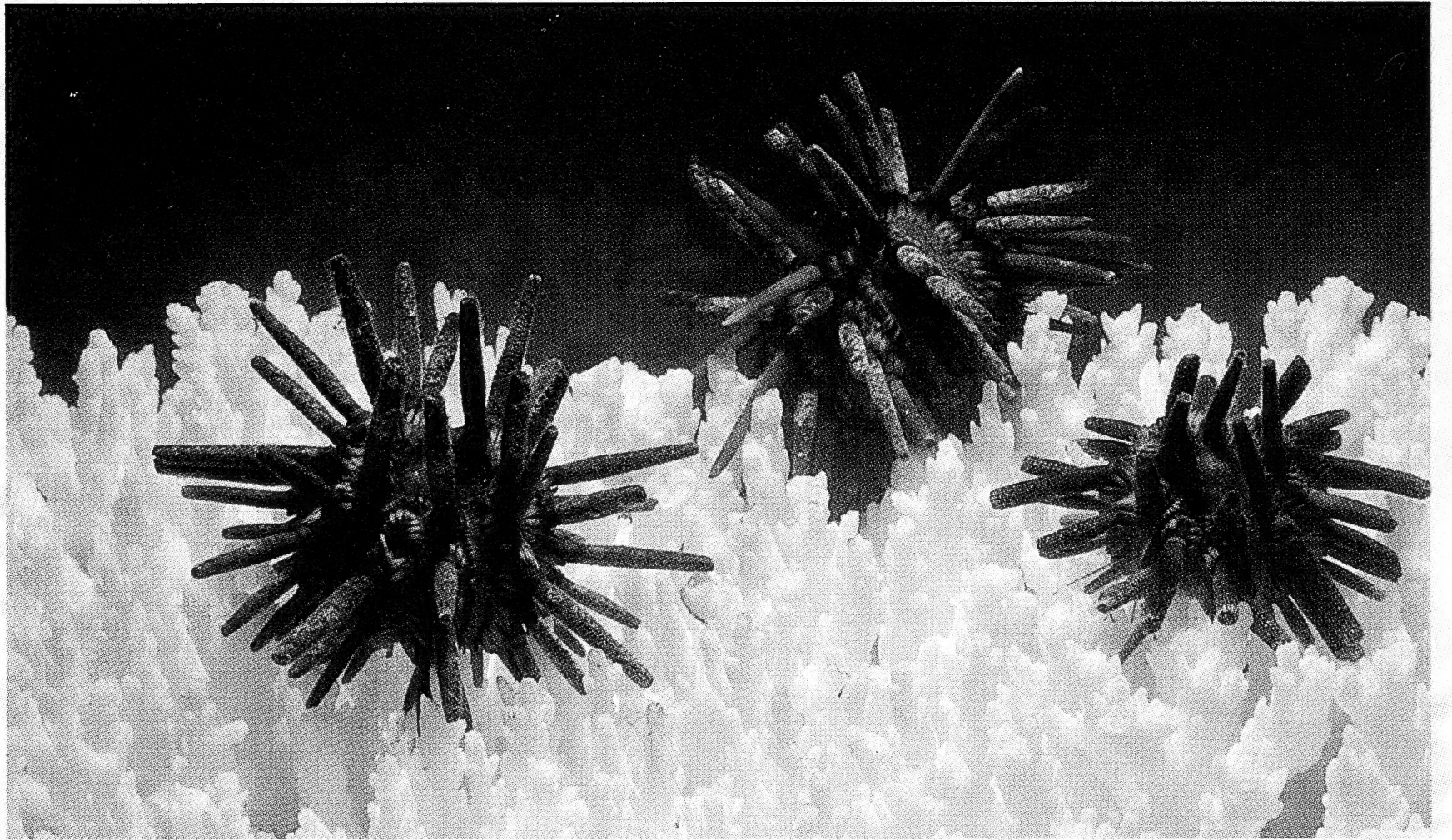
testes. Males of species with larger testes are believed to produce more sperm and thus to be better able to dilute the sperm of their rivals. And testes size does seem to correlate with the strategy males adopt for fathering young. Males that fight for their females, such as gorillas, have small testes, while males that share females, such as chimpanzees, have large testes and presumably compete with sperm.

This indirect evidence for sperm competition is clearest in primates because they are the best studied in terms of both anatomy and behavior. Biologist A. Harcourt of the University of Cambridge and his colleagues found that testes size correlates with mating strategy in most of the 33 species of primates analyzed.

For example, black gibbons, tree-dwelling lesser apes from the rain forests of Southeast Asia, mate in pairs. A gibbon couple stays together for years, raising young and defending their territory with a rousing duet of hoots. In contrast, crab-eating macaques, monkeys from the Philippines that are at home in both trees and water, live in troops with several males. Male black gibbons and crab-eating macaques both weigh about five kilograms (11 pounds), but, as the theory of sperm competition predicts, there is striking difference in testes size of the two species. Compared to the monogamous gibbons, the promiscuous macaques have testes 16 times heavier.

While primates present the strongest case for sperm competition in mammals, what is known of anatomy and mating behavior in other groups of mammals supports the theory.

The bovid family includes the delicate



Sea urchins, like these slate pencil urchins (Eucidaris tribuloides) in the Invertebrate Exhibit, simply release their gametes into the water. The more sperm a male produces, the better his chances of siring offspring. (Photo by Jessie Cohen, NZP Graphics)

African dik-dik, a large-eyed, shy creature that stands just over a foot tall. These bovids live in pairs on exclusive territories, and in keeping with the theory of sperm competition, the monogamous dik-dik has small testes.

Mating behavior is more complicated in another bovid, the Rocky Mountain big horn sheep. Big horn sheep live in large groups composed of many males and females. Females and dominant males form pairs, leaving many subordinate males in the group without mates. However, zoologist John Hogg of the University of Montana observed that subordinate males will regularly attack a

dominant male, butting and shoving in hopes of mating with his female. Often, the solo male big horn sheep successfully knocks a dominant paired male off balance long enough to run past him and quickly mate with his female.

As predicted by the theory of sperm competition, big horn sheep have large testes. Further supporting the hypothesis that big horn males try to increase their chances of fathering young by diluting each other's sperm, most dominant males mate with their female right after a solo male temporarily "steals" her.

Like primates and bovids, baleen whales fit the sperm competition theory, according to NZP biologist Katherine Ralls and Robert Brownell, Jr. of the U.S. Fish and Wildlife Service. Humpback whales, named for their high, rounded back, mate in pairs. A male defends his female with spectacular threats, such as by inflating his white throat, which contrasts sharply with his black head, and exhaling underwater to create a screen of bubbles between the mated pair and the rival. If threats are to no avail, the defending male attacks and often wounds his rival with violent tail lashes and open-jawed lunges.

Such staunch defense keeps rival males from mating with paired females, and, fittingly, humpbacks have relatively small testes—a mere 40 kilograms (about 90 pounds). Another species of baleen whale, the all-black right whale, has truly



There is fierce competition for females among gorillas (Gorilla gorilla), which live in small groups of females and offspring led by a dominant "Silverback" male. (Photo by Jessie Cohen, NZP Graphics)



Male lions (Panthera leo) fight for control of female prides, but control of a pride may be shared by several males. Females mate with all of the pride males, perhaps resulting in sperm competition. (Photo by Craig Packer)

leviathan testes that weigh nearly 1,000 kilograms (about 2200 pounds). This 25-fold difference is particularly remarkable because the right whales' body weight is only twice that of humpbacks.

Consistent with the sperm competition theory, male right whales do not fight for females. In fact, males are extraordinarily tolerant of each other. A female right whale has been observed mating with two males simultaneously: She floated on her back and had one male on her right side and the other on her left.

The mating behavior of most mammals has not been characterized well enough to tell if males compete with sperm. However, thanks to the strong

correlation between testes size and mating behavior in mammals such as primates, bovids and baleen whales, researchers can use relative testes size to predict mating strategies in other groups of mammals.

Future observations of how animals mate will teach scientists whether males of all species in which females are shared also exhibit sperm competition. What's more, further research may reveal other intricate and subtle mechanisms evolved by animals to increase their chances for success in the mating game.

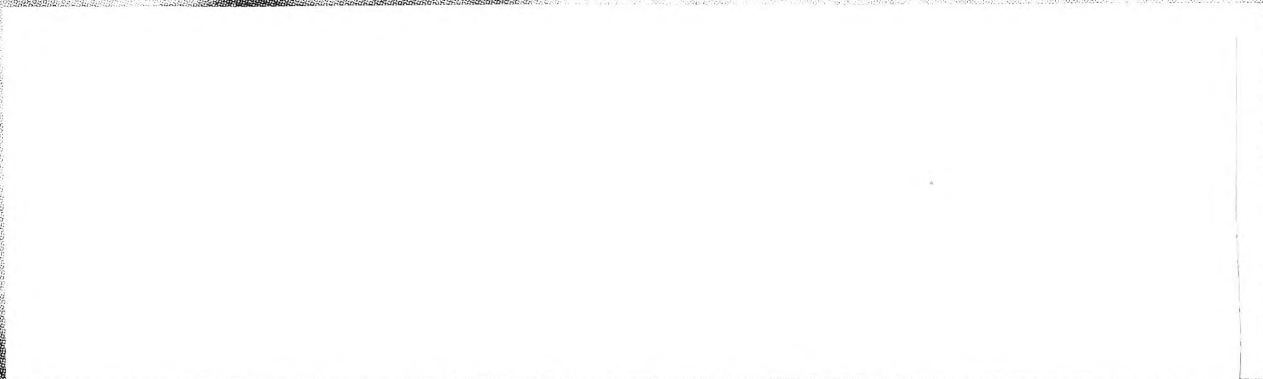
In predicting how acceptance of his theory of evolution by natural selection might revolutionize biology, Darwin stat-

ed "...when we regard every production of nature as one which has a history; when we contemplate every complex structure and instinct as the summing up of many contrivances, each useful to its possessor, nearly in the same way as when we look at any great mechanical invention as the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen; when we thus view each organic being, how far more interesting will the study of natural history become." On this, as on so many topics, Darwin was right. From clashing antlers to competing sperm, the deeper scientists delve into the workings of nature, the more interesting it becomes. □



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